Machinery on the Farm

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Machinery on the Farm

BY

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WITH A FOREWORD BY

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FOREWORD

When human labour is cheap, as it was in the slave states of the old civilizations which have disappeared, there is no incentive to apply labour-saving mechanical power. In agriculture, labour has, as a general rule, always been cheaper than in urban industries. Imported cheap food, which contributed so largely to the industrial prosperity of this country from the middle of the nineteenth century until the last war, was produced either by land workers whose wages were so low that they lived in poverty, or by the exploitation of virgin lands in the Western Hemisphere which has left the soil impoverished. The home-produced part of the food we consumed was also cheap because it was at the expense of a low standard of living of our agricultural workers, and at the expense of the capital invested in the industry by landlords and farmers.

In North America, however, scarcity and higher cost of labour led to the application of mechanical power in the shape of the tractor and the Combine for the cultivation and harvesting of grain. The scarcity of labour and rise in wages during the war hastened the application of machinery for harvesting maize and cotton, which had formerly been done by cheap labour, especially in the Southern States.

In this country the rapid rise in the cost of labour in the last six or seven years, together with a guaranteed market at a remunerative price, which gave confidence for the investment of capital in Agriculture, has led to a rapid increase in the use of labour-saving machinery. The number of tractors has increased from approximately 60,000 in 1938 to 261,180 in 1948, and the number of Combine harvesters has risen to 5230.

It seems probable that this process of mechanization will spread to all countries, even those where agricultural methods have not changed for a thousand years or more. Native races in Asia, Africa and South America, where seventy per cent or more are engaged in food production, are beginning to break out in revolt against their poverty. Their legitimate demand for a higher standard of living can be met only by increasing output per man, which can be done solely by modernizing their methods, including mechanizations suitable to their conditions.

Apart from the need for a better standard of living for these peasants, the rapid increase in the population of the world makes it necessary to increase food production in all parts of the world.

The day of cheap food for this country by the plundering of virgin lands and by the exploitation of poorly paid workers, is drawing to a close. For Britain this is an economic factor almost as important as the loss of our overseas investments. However that may be, there can be no doubt that the rapid development of mechanization, both for labour saving and increased food production, is essential for our economic prosperity.

There is another aspect of mechanization which is worth while referring to. Some writers have given a beautiful picture of the fine healthy life of the farm worker—" Oh! to be a farmer's boy ". I doubt whether any of these writers have walked between the shafts of a plough in November, or brought in turnips in a cold, wet day in December, or done the back-breaking work of emptying a dung court by hand and then gone home to a house where the water for the wash-up needed after dirty work has to be carried from a spring and heated over an old-fashioned and often rickety kitchen fireplace. Mechanization, which can make all such hard work easier, should go hand in hand with modern housing for workers, the remodelling of obsolete farm buildings to make them suitable and large enough for holding modern equipment, and the carrying on of such work as can be done under cover in bad weather. The application of modern engineering to agriculture, in addition to increasing output per man and lowering the cost of production, can make farm work as attractive as urban industries.

In this book, the manuscript of which I have read with great interest, the Author gives an historical account of the development of agricultural equipment, and brings the story up to date with illustrations and descriptions of the most modern machinery needed for all kinds of production, I am glad that he has not forgotten the needs of the small farmer.

The historical account shows that a high proportion of the fundamental new ideas for applying mechanic power to agriculture originated in this country, though in many cases they were developed and appeared first in America. The latest developments show that we have not lost our inventive genius or our engineering skill. With the urgent need for maximum efficiency in agriculture in all countries, there should be a great future for the agricultural engineering industry in meeting the demands both for the home market and for export.

This is a book written by a man who has had a long and expert experience of both agricultural engineering and practical farming. It will be read with pleasure and profit by all progressive farmers who realize that to-day mechanization is the key to efficiency in agriculture.

JOHN BOYD ORR.

AUTHOR'S PREFACE

At no time in history has mechanical power been put to greater use in agriculture than during the past six years. It is a very old but true saying that " Necessity is the mother of invention ", and never was this more obvious than during the war years, owing to shortage of man-power and to the abnormal conditions prevailing.

If farmers did not mechanize to the extent the spectator might have expected, it was not because they did not know about labour-saving equipment, its structure and its use. Sir John Boyd Orr put the position of British farmers very clearly in his contribution to the 1939 volume *Agriculture in the Twentieth Century*, when he pointed out that " The industry needs more money to make itself more efficient ". It is much to be regretted that in the last hundred years the only two periods during which the farmer, agricultural-machinery manufacturer and dealer have got reasonably good prices have been during the 1914 18 and 1939–45 war years. It is hoped that, by the fixing of farm workers' wages and the prices of farm produce, we will never return to the long uneconomic periods that we experienced in the past.

It has often been pointed out to me that the best brains have never been attracted to the agricultural-engineering industry, and to a large extent this is true, as the miserable wage offered in return for what was produced, compared with other industries, did not encourage good engineers to enter the industry. Under present conditions, which I hope will continue, much more attention is being given to the mechanization of farms, but still a great deal remains to be done in that direction.

In the meantime, and for some years to come, I feel that it is, and will be, impossible to write with much finality about farm equipment, as engineers and inventors will develop new ideas so frequently, encouraged by an insatiable demand.

Although we have by no means reached the stage of full development in the mechanization of farming, the attainments in the past have been of no mean order, taking into consideration the conditions with which both makers and users had to contend. From

the ox-plough era we progressed into the horse- and steam-tillage period. It in turn has been supplanted by the day of the oil-engine and tractor, and almost equally revolutionary was the dawn of the rubber era on the farm. Of these the tractor has proved the most far-reaching innovation. It has made possible the almost immeasurable idea of "power farming" and has lightened farm labour to such an extent that it has added many years to the effective working life of farm hands. Mechanization will control so much the future economy of the farm that research, at present preoccupied with near-hand detail, can be foreseen focusing on broader factors in attaining the maximum benefit from mechanical equipment.

"Mechanization" and "power farming" are terms which have created a false impression in many minds. Too often they have been regarded as synonymous with the use of "Combine" harvesters, tractors and huge farms. The need for mechanization on the small farm is equally great and the demand for suitable equipment to meet the needs of the medium-sized and small farm is a large one. Most manufacturers of equipment are now keenly alive to this position.

Although great strides have been made during the last few years in the mechanization of agricultural operations, much more has yet to be done. Ample scope is offered to the research engineer to see that the tractor is not only used for pulling but is so constructed that the driver has merely to operate a lever to bring any of a number of implements into action. The tractor should also be made much more inviting for the operator by supplying with it a more comfortable seat and a suitable cab for protection against bad weather.

For the benefit of those who may not be familiar with farm equipment and its functions I deal in this volume with the various types of machines in the sequence in which they are used in turn on the farm during the seasons of the year.

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INTRODUCTION

Farm equipment forms one of the most important subjects for study at any time, but especially in these days when world food surpluses have disappeared and in every land the need has arisen to step-up production with all the aid that can be derived from the mechanization of the farms. For the benefit of students it is necessary at the outset to trace a few of the peculiarities which mostly distinguish farming from other industries. There is, for instance, little or no similarity between the policy pursued on the farm and that in the factory in the matter of mechanization usage.

Down on the farm conditions vary between field and field, hour and hour, season and season. There is no consistency in the conditions dictating the when and the how of machine operations as there is in the factory. The state of the soil and the weather creates almost hourly interference with any preconceived ideas about a time schedule. It makes up the machine owner's mind for him or her.

In the factory the machines may hum practically every working day through the year. It is not so on the farm, and that is one of the great disadvantages with which agriculturists have to contend. Not only have they to possess an extensive range of machines and implements, but, with the exception of the tractor, most units work but a few hours in the twelve months.

A trailer-binder may only be in action for a spell of eighty hours annually on a medium-sized holding. That is an average experience. The mower is another machine, the yearly use of which is even less than that of the binder. An average is certainly not more than two or three days per annum. Agriculture, therefore, on a business turnover that is far from so speedy as that of the factory, has to be equipped with quite a variety of costly, infrequently used machines and implements.

This paraphernalia has grown through modern invention until average implement sheds are no longer adequate in capacity to store it all. In addition to the list of portable and automotive machines taxing the floor space in the shed, there is a wide range of fixed or stationary items in the other buildings, which, to a

certain extent, share the liability to spend many idle moments throughout the seasons.

Another farming peculiarity among industries is one that indirectly, but vitally, reacts on equipment policy. On a given turnover the farm employs more people than does the average of other businesses. This, with the rise in wages, has compelled farmers to place even greater emphasis on mechanization. In spite of that accentuated mechanical aid the husbandman's slow turnover of from one to six years still leaves him with problems in plenty. His line of enterprise is no sinecure. It is no push-button job. He has to follow up with the most skilful administration.

That means that the land has to be worked while in proper condition. It must be well dressed with farm-yard manure, fertilizers, and correctives. It should have no defective drains, and fields ought to be adequately watered. Livestock and plants alike have to be carefully chosen on performance records. Then and only then will the modern equipment on the farm justify itself.

It is not, however, enough to understand the position of the farmer in the technicalities of his task within the confines of his fields and how and to what extent he mechanizes his operations. The student would do well to realize from the start that there is another peculiarity which has vitally affected farming in the past, in the present, and no doubt will do so in the future—just as it has put its mark on even the destiny of nations. While the population of the land is engaged in what is the central industry, they have the least influence of all on the affairs of state. The voice of the towns and cities is supreme. That tendency has gone too far. It should not be so, but that is how it will remain as long as the pastoral vote is completely dwarfed by that of urban and industrial communities. International perplexities seem to grow with the years. Perhaps the remedy could be found in what one might call an approved form of " proportional representation "— a fifty-fifty pastoral-urban seating of our House of Commons and of corresponding senates in other lands?

With the foregoing brief preamble the stranger to agricultural fundamentals may be all the better able to fit his studies of equipment into the scheme of things upon up-to-date farms, from the small place, where a modest range of appurtenances is all that is called for, up to the larger holdings where thoughts run in the direction of a full range of appliances and in terms of extensive " power farming ".

CHAPTER I

Power

Internal-combustion Engines

The introduction of the steam engine was the first step taken in the matter of harnessing power to field operations. Oil and petrol engines have, however, to a large extent superseded the steam engine in this connexion. The length of time necessary for raising steam, and the extra care needed in the management of it, have rendered the steam engine much less important for agricultural purposes than the internal-combustion engine.

The advent of the internal-combustion engine in the last decade of the nineteenth century was to lead to and make possible the greatest revolution in the history of agriculture. It brought about mechanized, or power, farming with a speed of transition that could not otherwise have been attained, and it therefore is fitting that the subject of internal-combustion engines should occupy pride of place in the sequence in which it has been decided to describe in this book the various classifications of farm equipment. These notes deal with the mechanical evolution of this power-unit and not necessarily with the individual models of the multitude of present-day makers.

The internal-combustion engine affected the lives of millions in the early decades of the twentieth century, in that it made power easily available for the first time and for almost every purpose. To-day the motor vehicle, car or tractor, aeroplane, submarine, and the motor ship are commonplace, but when the century opened they were looked upon with both suspicion and derision.

The closing years of the Victorian era were solidly founded on steam. Everything relating to the steam engine was solid, substantial, and built to last—the very epitome of British workmanship. No short-cuts to power were favoured in our economy—what could be better than coal, a boiler, and an engine?

The internal-combustion engine had, therefore, to meet a tremendous conservatism quite content to rely on proved per-

formance. That it won the day finally is due to the extraordinary genius and persistence of the early inventors who would not accept failure as the answer.

Otto's Four-stroke Idea.—For many years before the close of the nineteenth century, inventors, both on the Continent and

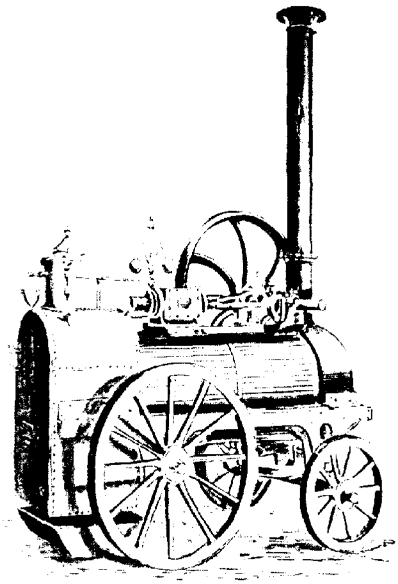


Fig. 1.1.—An early portable steam engine
(*Ransomes*)

in Great Britain, had devoted much time and money in experimenting with "explosion" engines, as they were named, and their early attempts seemed, and were, very weak attacks on the prestige of the steam engine; but the inventors refused to accept defeat, and the crowning success came in 1876 when *Herr Otto*, a German scientist, discovered the *four-stroke cycle*. Hitherto inventors had not been able to shake themselves clear of the mechanism of the steam engine and insisted on following it too closely. In it, every stroke is a power-stroke. It took many years before it was realized

that a gas or oil engine would work efficiently even if it had only one power-stroke in four. It is easy to appreciate the point of view of inventors who could not bring their minds to consider an engine so apparently ineffective.

Yet that is how the problem was solved, and it is to the genius of Herr Otto, who first stated the method and made an engine with three idle strokes in four, that we must render homage for

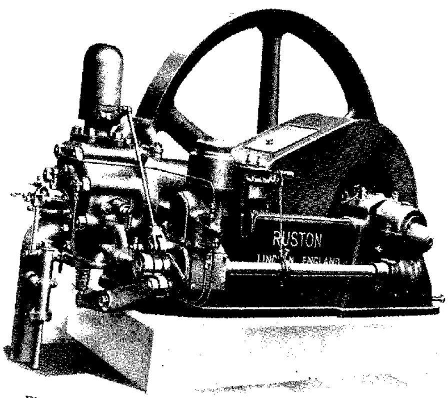


Fig. 1.2.—Horizontal oil engine, single cylinder ($5\frac{1}{2}$ to 295 B.H.P.)
(*Ruston & Hornsby, Ltd., Lincoln*)

the great invention. It was ultimately to lead to engines with an efficiency far beyond steam-driven types. Many attempts have been made since then to introduce *two-stroke engines*; that is, one idle stroke in two. They have met with only moderate success, and to-day by far the greater majority of all internal-combustion engines are four-stroke types working on the "Otto" cycle.

As already stated the four-stroke principle means that an engine requires four strokes to complete what is known as its "cycle", that is, to complete its sequence of operations, when it begins all over again. In a steam engine the piston is pushed by the steam from one end of the cylinder to the other, whence steam again pushes it back to where it started, so that the piston is always

working, every stroke being a working stroke. The four-stroke internal-combustion engine is quite different, the piston is driven from one end of the cylinder to the other by exploding gases (the power stroke), it must then return to where it started so as to blow out the burned gases. That done, it must travel again to the other end, this time drawing in an explosive charge, then it again travels back to the starting place, at which point the explosion occurs. Having thus performed one power-stroke it had to do

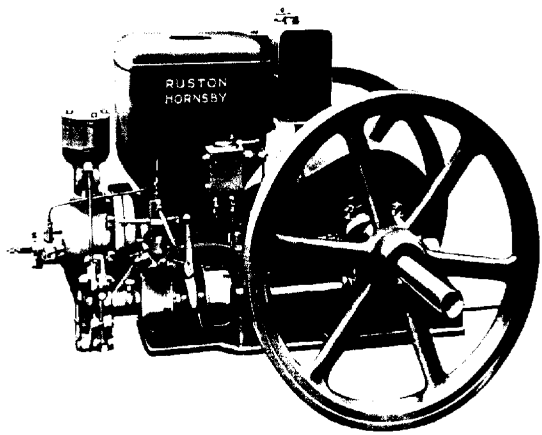


Fig. 1.3.—Small horizontal hopper-cooled engine ($5\frac{1}{2}$ to 10 B.H.P.)
(*Ruston & Hornsby*)

three further strokes (idle strokes) before it could do another power-stroke. The power for performing these idle strokes comes from the heavy flywheel which in turn is driven by the power-stroke.

After this great discovery was made many investigators began work on it as it was obvious that as it became better understood great advances could be made on the original design.

Daimler's Carburettor.—First among the great names of those who contributed to this advancement was *Daimler* in Germany and *Akroyd Stuart* in Great Britain, and it is from their inventions and designs based on the " Otto " cycle that all modern

engines are derived. These two inventors took diverging courses in development. Daimler led the way in drawing in or aspirating an explosive mixture either through a *carburettor or vaporizer*, and Stuart adopted the principle by which air only was drawn in and compressed into a hot bulb, where a spray of oil was injected just as compression was complete.

Daimler's method led directly to the motor car and aircraft engine as we know it to-day, and to a large number of paraffin engines designed to employ his principle, which applies to petrol and paraffin oils that are readily vaporized. Akroyd Stuart's design led towards the engine which uses heavy crude oil; but it is almost universally known as the *Diesel engine*. This point requires some explanation.

Stuart v. Diesel.—Akroyd Stuart claimed strenuously that he was the inventor of the Diesel engine. He was one of the early products of technical and scientific education in Great Britain, and in 1890 he patented two engines, one of which is described above and became known in the trade as a " late-injection " or " solid-injection " engine. The term " late " was applied because the formation of a mixture was delayed until compression was complete or nearly so; his other engine drew in air at the same time as fuel was injected into the hot chamber; this formed an explosive mixture which was *compressed into the bulb* and finally ignited there. He therefore had clearly in mind that different methods could be employed, one compressing an explosive mixture and the other air only, and it was on this latter point he carried on his great dispute.

Now, Dr. Diesel, a distinguished German scientist, had spent many years examining the possibilities of the internal-combustion engine from an almost independent point of view. He had satisfied himself, from mathematical and theoretical investigations, that an engine could be designed to burn *coal dust* directly in the cylinder, if the cycle of operations which he laid down was carried out. He adapted the Otto cycle as Stuart had done; that is, he did not draw in an explosive mixture, but air only. While Stuart used only moderate compression pressures and a hot bulb, Diesel used what were then immense compression pressures (in fact, high enough to make excessively hot air), and into this very hot air he blew the coal dust, which immediately burned in the hot air without raising the pressure further. This pressure he maintained for an appreciable time while the piston was moving forward, thus

giving a power-stroke. The coal-dust engine was not a success, but when fuel oil was substituted it was outstandingly so.

There were two differences between Diesel and Stuart. Diesel claimed that high compression was a necessity before injection of fuel, but that injection of fuel would not cause further rise in pressure. Stuart stated two years prior to Diesel that compression should be carried out before injection; but how far that compression should be carried, he did not state; yet, he expected and obtained

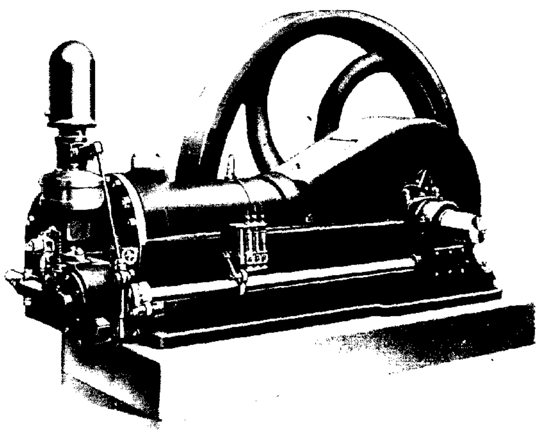


Fig. 1.4.—Horizontal cold-starting Diesel oil engine (16 to 70 B.H.P.)
(*C. F. Wilson & Co., Ltd., Aberdeen*)

a rise in pressure. Diesel blew in his fuel with air, Stuart used a pump (solid injection). There were distinct differences between the two patents and, apart from Stuart's prior claim to compressing air only (a not unimportant claim), he had little room to complain.

The real grievance came later. Diesel built many engines to his patent specification, and these were the most economical engines built; but they were heavy, and required very high air pressure to blow in the fuel. The compressor to produce this air was complicated and expensive. Inventors and designers challenged the use of this compressor, and believed that the fuel could be injected much more simply by pump. Research went on, and it was found that this could be done, but the pump method (Stuart's method)

could not be used without creating a rise in pressure (also Stuart's method). This was a distinct departure from Diesel's patent, where one of his claims was that there was no rise in pressure. When this happened, Stuart's claim to be the inventor of the so-called Diesel engine became much more real, and he appears to have had a distinct grievance. In any case, the modern Diesel engine uses high compression according to Diesel's patent, but departs from that patent, by using Stuart's pump injection and

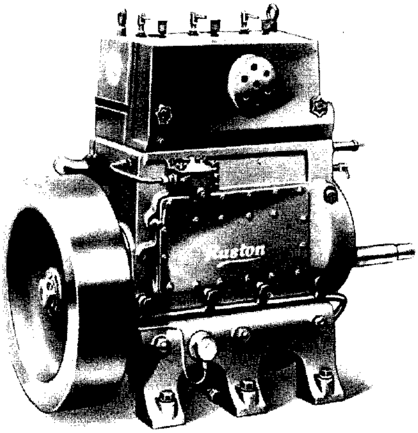


Fig. 1.5.—High-speed vertical oil engine ($3\frac{1}{2}$ to 45 B.H.P.)
(*Ruston & Hornsby*)

rise in pressure; thus, the modern Diesel engine is strictly a descendant of Herr Otto's patent by way of an Englishman, Akroyd Stuart, and uses only one point from Diesel and two from Stuart. It might be said that Stuart never visualized high compression, as we understand it, but it is more certain that Dr. Diesel would not have been associated with pump injection and a rise in pressure, as these were contrary to his theoretical conceptions of how his invention worked.

Having thus tried to put the claims to the credit of the " Diesel " invention in their proper light, we may pass on to see how the Otto-cycle engine was applied in agriculture with such tremendous effect.

Otto's Idea Took Root.—As soon as the principle of the four-stroke cycle was thoroughly grasped in Great Britain and on the Continent, a perfect host of inventors and designers set to work discarding all the older ideas and concentrating on the Otto cycle. They produced a wonderful array of engines using petrol and paraffin oils. Each designer seemed to have ideas of his own as to how the explosive mixture should be made; with *petrol* this was comparatively easy, as no heat is required to make the mixture.

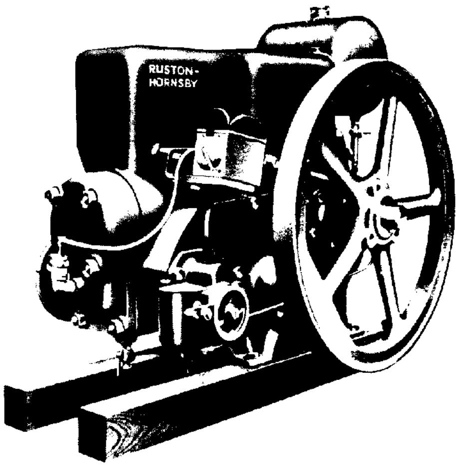


Fig. 1.6.—Petrol-paraffin engine (3 and 4½ B.H.P.)
(*Ruston & Hornsby*)

Nevertheless, many designs of carburettor were made before the modern carburettor was evolved, all with the view of producing an explosive gas. Good carburettors were in existence by the beginning of the century, and the early motor cars were using them successfully. Modern carburettors are derived directly from them, and these allied to the Otto cycle combine to make the modern motor car and tractor engines.

When it came to using the cheaper and safer fuel, paraffin or kerosene, the problem was more complicated, as this fuel cannot be carburetted in the same way as petrol. It is necessary to turn it into a vapour by applying heat, and this set a difficult problem for the inventors and designers. The first attempts were to try

to make the paraffin into a vapour in a separate chamber, and then to draw it into the engine as a gas, mixing it there with further air, compressing and igniting it in the usual way. *Priestman* had an engine of this type working in 1888, and it was exhibited at the Royal Agricultural Show at Nottingham in that year. By 1894 there were eleven engines on exhibition at the Cambridge Show, and the names of Hornsby and Crossley emerged. By 1895 some twenty different makers of oil engines had appeared. Progress was rapid; in another ten years the oil engine was produced in its present form by a large number of makers all over Great Britain.

Toward Greater Simplification.—All the engines in the later stages had shed the cumbersome apparatus, and simple, direct methods were employed, which gave to the farmer a most reliable and easily managed power-unit. The first simplification came when it was realized that a vaporizer need not be complicated, and that it could be made as an attachment and extension to the engine cylinder. It was kept hot by a continuously burning lamp, which also heated a hot tube directly connected to the interior, and gave automatic ignition. The fuel tank was usually seated as a cast-iron vessel on the top of the cylinder, and the fuel was led to the air-inlet valve on the vaporizer by a pipe ending in a controlling cock which could regulate the quantity drawn in with the air. The whole of the air was drawn in at this air valve and so formed an explosive mixture very simply. The valve was automatic, that is, the forward movement of the piston sucked it open and literally drew in oil and air for the mixture. Governing was effected by keeping the exhaust valve open and so preventing the suction stroke which then took place through the exhaust valve, leaving the air-and-oil valve closed.

There were variants; some preferred to have the fuel tank on the floor or incorporated in the bed-plate whence the suction stroke lifted the fuel easily to the vaporizer. Others preferred to pump it up to a little cup which was just the right size for one charge when full—any surplus was arranged to flow back to the tank. All methods were the very essence of simplicity and were easily managed by the labour available.

The Hornsby engine took an independent method already indicated. It also worked on the Otto cycle and, while the suction stroke was being performed, it pumped a measured quantity of fuel into a previously *heated bulb*; the air drawn in by the suction stroke was compressed back into this bulb and the mixture exploded

by the heat of the bulb. Governing was effected by varying the quantity of oil pumped. The hot bulb did not require a continuously burning lamp, as the bulb was kept hot by the recurring explosions. The compression pressure on all these engines had to be adjusted to suit the particular brand of paraffin in use, the most common being Russian and American fuels. Ready means were provided for this, but usually the engines were adjusted for it before they left the makers' works, if the brand of paraffin to be used was stated.

Nearly all makers succeeded later in discarding the continuously burning lamp and so got rid of the only really troublesome part of the engine, but they all required a lamp to start. This was usually a Swedish lamp.

Immense numbers of these engines were built between 1900 and 1920, supplying a large home market and an almost insatiable demand abroad. Russia, India, Egypt and South America were large users and there were few countries which did not import them.

A Farming Revolution.—At home they created a revolution in farming, every kind of machine was driven by an *oil engine* of some kind. Threshing, grinding, bruising, milking machines, &c., were rapidly brought into power-drive. The remarkable cheapness of the power, both in first cost and running, was such that it launched mechanization on the farm before that word had even been used in that connexion.

The steam engine of our fathers, which was so firmly entrenched at the start, was only available at high capital cost and increasingly high running costs. It was thus beyond the reach of everyone but the large farmer. It disappeared in front of the oil engine which proved to be no less reliable and far more economical. Many of these engines are running to-day, still doing service after forty years, and are good for many years to come.

Yet the engine described above has not been in production for the last twenty years, as it was succeeded by a still better unit. This superior type is the so-called Diesel engine, already mentioned, and it uses still cheaper fuel—crude oil.

The only engine of those described above which could run on crude oil was the Hornsby model, which did so with distinct limitations, as any engine using a low compression and a large hot-bulb could not cope with anything but high-quality crude oils. The other engines could not use oils heavier than paraffin.

An Attractively Cheap Fuel.—The use of crude oil had been a great problem to designers, the very low cost of the fuel being extremely attractive. The only engine known to use it was Diesel's engine already mentioned, but it was very heavy and very costly. It was therefore some time before designers had the courage to

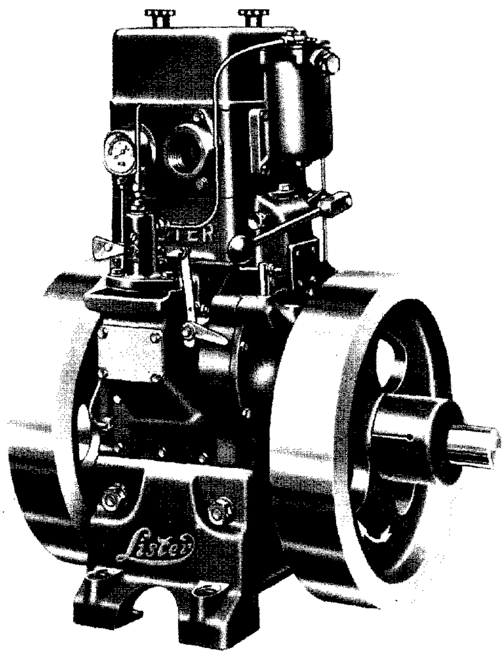


Fig. 1.7.—Single-cylinder Diesel oil engine (7/8 B.H.P.)
(R. A. Lister & Co., Ltd., Dursley)

" improve " on his work. The fact that Diesel used a compression pressure of 500 lb. per sq. in. (a much higher pressure than the explosion pressure on an oil engine) had been a deterrent, and compromising designs were brought out where a hot bulb was used, with a compression of about 250 lb. per sq. in., and the oil was not injected until the compression was complete. Explosion pressures of the 400–450 order were obtained and the engines could run on a very wide variety of fuels without any adjustments. The

hot bulb required a *blow lamp* to heat it before starting, but was not required after starting. This design of engine ran with an economy equal to that of a Diesel and was far cheaper to build.

No sooner was it working, than it was vastly improved by discarding the hot bulb and starting lamp, and raising the compression pressure to over 400 lb. per sq. in., the explosion pressure going up to 650 lb. per sq. in. In modern high-speed Diesels the compression pressure is now up to 500 lb. per sq. in. and the explosion pressure is up to 750 lb. per sq. in.

To-day, therefore, we have the results of some fifty years of steady progress. Chief among these attainments are lighter engine-weight per horse-power delivered, and a much higher efficiency on the amount of fuel consumed. Internal-combustion engines give about double the efficiency of the steam engine; petrol engines yield up to as much as 25 per cent efficiency, and Diesel types even approach 35 per cent.

The Tireless and Epoch-making Tractor

As noted, the internal-combustion engine made possible the tractor, which is the basis of the vast degree of mechanization in modern farming. The tractor, which has brought about the huge extension of the crop-producing land of our country, was introduced for the first time on a large scale during the 1914–18 war. Early machines were very different from those at present in use, but fundamentally, the design is unchanged. This may be taken either as a tribute to the designers of the early machines, or as a comment on the conservatism of the industry. At any rate, the troubles to which the early machines were subject in the hands of unskilled operators retarded the progress of agricultural mechanization until recently. Not only were tractors themselves prone to breakdown, but the combination of equipment built for horse work and the power of the paraffin engine proved too much for the lighter construction of the horse machine, with the result that stoppages were the rule. At the same time, men trained in horse work could not be induced to pay sufficient attention to the wants of the tractor, small though they were, and many fine machines were ruined through neglect. Even now, when a new generation, familiarized with the internal-combustion engine, is taking charge, I am strongly in favour of the extension of training classes for

tractor drivers, so that they may fully understand the failings as well as the potentialities of the machines they control.

The increasing favour for the tractor has been accentuated by one or two far-reaching developments. The most significant of these were surely the introduction of pneumatic tyres, and later of the *row-crop tractor.* So popular has the latter become that in America about 80 per cent of new tractors sold are row-crop models. The principles on which these machines are constructed are such that the tractor is now suitable for a far wider range of duties. The contemporaneous dawn of the rubber era contributed to the tillage revolution brought about by the tractor, for it is dependent on pneumatic tyres for much of its versatility. The service rendered by the rubber industry has been inestimable, and in agriculture the uses of rubber extend far beyond the tractor.

Compared to horse tillage, tractor cultivation has at least trebled the amount of food produced per man employed, and this tremendous advantage has been reflected in the rapidity with which the use of the tractor has spread, assisted by improved prices for the products of the farm. The rate of increase in popularity of the " steel horse " is well illustrated by the tractor population in Britain in the years 1939 and 1947. It rose in these eight years from 60,000 tractors to over 260,000, the latter figure working out at one tractor to every 71 arable acres.

They are ousting the work horse from field operations at a corresponding rate, more especially in the English-speaking world, but assuredly, before long, they will have to be used by the governments of coloured peoples to displace ox-ploughs and as the chief agency to promote efficient and speedy tillage in attempts to prevent the recurrence of famines.

As a mobile or stationary power-unit its versatility is amazing, and continues to extend from day to day. Ahead also lies the development of tremendously powerful models to operate on gigantic reclamation, soil-warping, irrigation, ditching, and road-making schemes. World food surpluses have disappeared, perhaps never to return. Every square foot of soil will have to be wrenched into food production, no matter how forbidding the terrain may be. There follows a list of some of the tasks tractors have been used for within a few weeks of the time of writing:

Ploughing; cultivating; rotary cultivating; ridging; potato planting; ridge splitting; harrowing (spring-tine, rigid-tine or disc); hauling seed sowers and manure distributors; spraying with

liquids or powders; farm-yard manure loading and spreading; hauling rollers; hoeing; hay mowing and hay collecting; pulling "Cut-lifts"; compressing grass into pit silos; hauling trailers; "Bulldozing"; hauling binders; hauling and driving threshing machines; driving chaff cutters and grinders; draining by machine; circular sawing; air compressing; rock drilling; hauling by winch and cable; and pulling up trees and hedges.

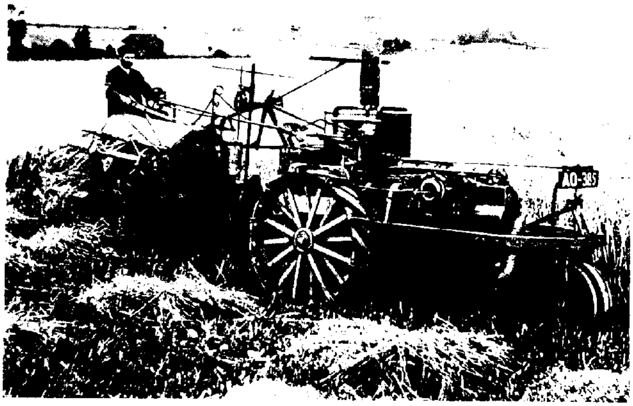


Fig. 1.8.—"Ivel" tractor (1902) pulling "Albion" Binder
(Dan Albone, Biggleswade)

An Important Innovation.—Perhaps the most significant development in recent times has been the introduction of the *hydraulic lift*, whether incorporated in the attachment arrangements for the implements, as originally produced; or as a completely detachable device, as supplied by the largest tractor manufacturer in the world. Especially interesting is the incorporation with the hydraulic lift of a device for automatic control of the depth of cultivation. Here, at last, we find the realization of the hope that the tractor need not be just a mechanical horse, but can form an integral cultivating unit with its implement. The problems inherent in the design of a single-unit ploughing machine are by no means easy to solve, however, and perfection has not yet been attained;

but these latest devices form a most interesting contribution to the list of designs which have aimed at this function.

If space permitted it would be fascinating to outline the evolution, in the last decade of the nineteenth century, of the first farm tractors constructed in Britain and America and dependent for

Fig. 1.9.—" Atom " tractor (1 B.H.P.) discing
(Barford (Agricultural), Ltd., Grantham)

power on the internal-combustion engine. One was made in U.S.A. in 1890 and another won the silver medal for Ruston & Hornsby at the Royal Show in 1897. Then, in 1902, Dan Albone of Biggleswade, Bedfordshire, built and put into production the " *Ivel* " *tractor*. This was a three-wheeled model, and it will be seen from fig. 1.8 that the operator is driving both the tractor and binder

from the binder seat. An " Ivel " tractor, built in 1905, was in use up to a few years ago—surely a great record of almost forty years of work. There have been many changes since then, and every year still brings some new design of tractor.

A Dainty Performer.—One of the smallest tractors made to-day is the *Barford "Atom"* (fig. 1.9). It is fitted with a four-

Fig. 1.10.—" Cultmate " tractor (3 h.p.) in action
(*Shillan's Engineering Co., Ltd., Banbury*)

stroke air-cooled engine of 98 c.c. capacity. The weight of this complete tractor is only 177 lb. and it is claimed that under normal working conditions the fuel consumption does not exceed $\frac{3}{4}$ pint of petrol per hour. As can be seen from the illustration the tank is carried behind the engine. Power take-off is provided in the side of the reduction gearcase, and the frame of the tractor is one piece

of mild-steel plate. Transmission is through a reduction gearbox with machine-cut gears totally enclosed, and a friction shock-clutch, for taking the jolt from the dog-clutch when starting up, is provided. Final drive is by roller chain, provided with suitable adjustment. Approximate speed is 1 mile per hour. This small but compact model is fitted with a complete range of cultivating, hoeing and grass-cutting implements. In fact, there is a full set of tools, including a wheelbarrow, for doing all the work that is necessary on a small market garden.

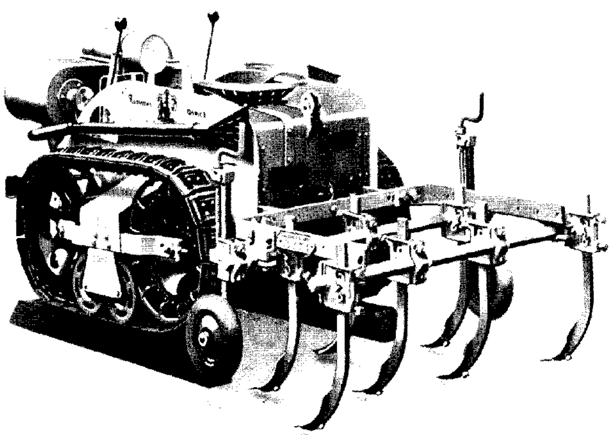


Fig. 1.11.—Ransomes' middle-weight (MG 2) tractor (6 B.H.P.) with cultivating tines attached

(Ransomes, Sims & Jefferies, Ltd., Ipswich)

A Versatile Light-weight.—Another product for light cultivation and market garden and nursery tasks is also one of the smallest and most useful of tractors. It is the "Cultmate" 3 h.p. (fig. 1.10), built by Shillan's Engineering Co., Ltd., Banbury. It can be used profitably in gardens and orchards and, being of very small dimensions, can be operated successfully in narrow space. This product is also equipped with a full range of implements for cultivation, and it can be easily transported on account of its lightness in weight.

Ransomes' Middle-weight.—Ransomes, Sims & Jefferies, Ltd., Ipswich, make a tractor of this class (fig. 1.11). It has a width

of 3 ft. 6 in. and weighs only 10½ cwt. It will do the tillage operations within the requirements of the market gardener and smallholder and is more powerful than the Cultmate. Fitted with a special tool-bar frame and having a full range of implements for cultivating, its fitments include hoe blade, ridging bodies, and potato-raising bodies which can be used on the same frame. Thus it will be seen that mechanization is not the preserve of the large farmer. The small man is being well looked after.

Great Power in Small Bulk.—The next tractor in size to the market-garden type is the Ferguson. This tractor with its

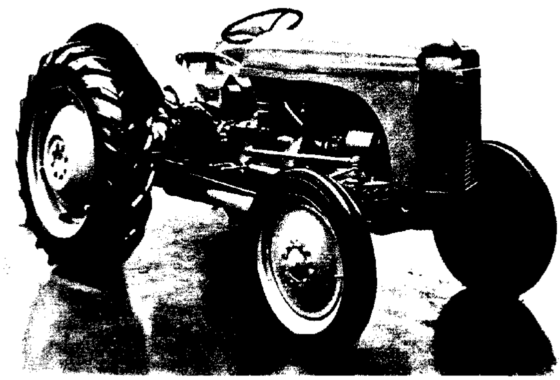


Fig. 1.12. -Ferguson tractor (develops 23·9 h.p. on belt)

own close-coupled implements and power lift is very popular on many medium-sized farms, and features surprising power, versatility and handiness.

Good All-round Performer.—Although slightly larger and more powerful the tractor built by *David Brown* Tractors Ltd., Huddersfield (fig. 1.13), may be termed in the same class. Like most other tractors it is a four-cylinder paraffin type, and is capable of pulling a two-furrow plough and doing all the necessary row-crop work, as well as carting turnips and grain crops on medium-sized farms. An important feature is that it has a high-speed gear for travelling along roads.

Fordson Major.—On account of the submarine menace during war years, 1939–45, it was almost impossible to obtain

tractors and tractor implements from U.S.A., from which country many came in pre-war years. Thus farmers were hugely indebted to the Ford Motor Co. for producing an enormous number of tractors during that period. It is characteristic of the Ford Company that despite the pressure of war work they found it possible to carry through a fresh development of the already well-known Fordson tractor; this is the new *Fordson Major* (fig. 1.14), to meet the need for a more versatile and adaptable unit, capable of per-

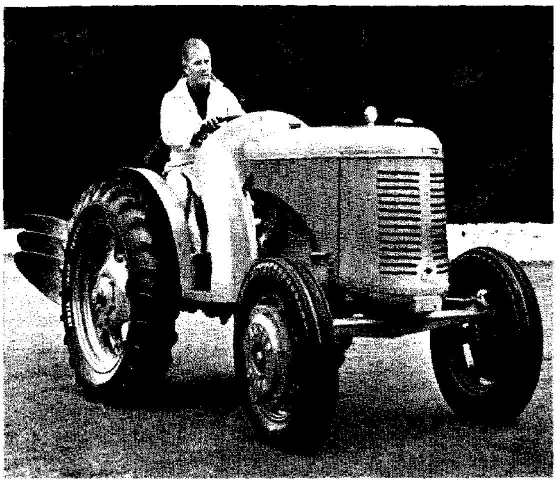


Fig. 1.13.—David Brown tractor (23 to 35 B.H.P.)

forming most jobs on a medium-sized farm. The Fordson Major's greater efficiency is due to a spur-gear drive which gives more draw-bar pull. The swinging draw-bar has been designed to suit the requirements of various types of implements. Larger rear wheels also contribute to its efficiency by giving better adhesion and more ground clearance. The driver's task is further lightened by the introduction of an improved clutch of a single-plate type and an independently operated transmission brake, the lever of which is conveniently placed on the right-hand side. There are other features of special value to the increasing number of farmers using attached implements designed for mounting to the tractor, e.g. the numerous locating pads on the rear-axle housing, the front

end, and the transmission housing; the *centrally placed power take-off* on the transmission housing to permit the drive to be taken to implements in the most direct manner; and the provision of a strong grille to protect the radiator core.

As a row-crop machine the Fordson Major has all the improvements embodied in the standard model as described above, plus special features needed in a row-crop tractor. Chief of these are the adjustable front axle and rear wheels to permit the tractor

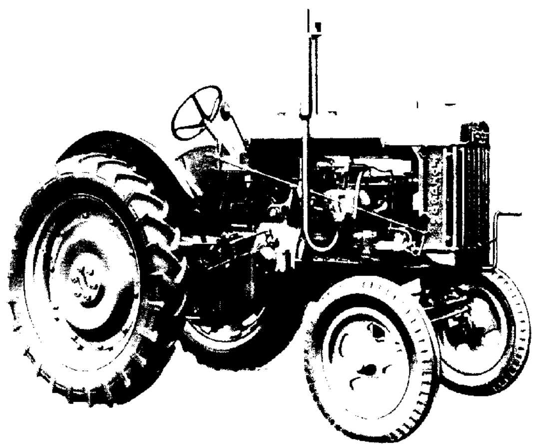


Fig. 1.14.—Fordson Major tractor ($28\frac{1}{2}$ B.H.P.)

width to be varied to suit any type of crop, the actual range being from 48 in. to 72 in. in 4-in. steps. The steel-wheeled model has a $4\frac{1}{2}$-in.-wide rim, and it is doubtful whether a 9-in.-wide wheel is necessary for heavy work. The independent brakes, which are also standard on the land utility model, are of the internal-expanding two-shoe type, operating on the countershaft controlled by two adjacent pedals, facilitating short turns in the headlands. The tractor is also fitted with the new *hydraulic lift* and *rear-end tool-bar*.

An Easily Replaced Engine.—One of the newest makes to appear is the *Nuffield Universal Tractor* (fig. 1.15) designed and built as a general-purpose and row-crop machine, weighing approximately 2 tons. Rated at 35 h.p. it can handle a three-furrow plough

under normal conditions, and is designed to take a wide range of row-crop equipment. It has ample power for doing ordinary haulage or belt work on a farm and, as illustrated, is a four-wheeled layout; but it can be converted to three wheels for certain classes of row-crop work. When there is only one tractor on the farm the Nuffield is of an ideal type and size.

The "heart" of a tractor is its engine, and the four-cylinder unit incorporated in this make is not new. It was made in very

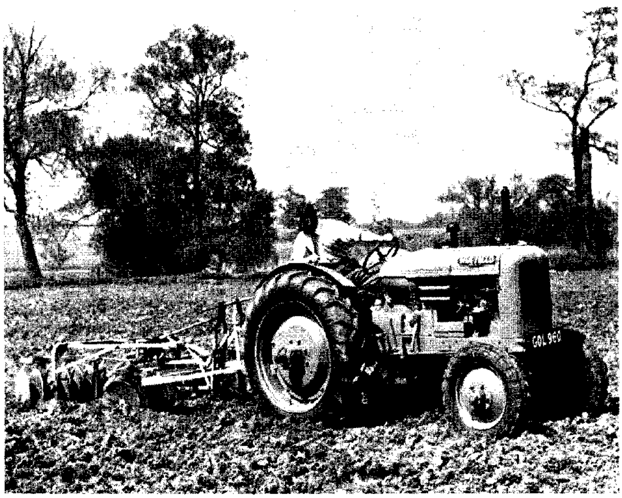


Fig. 1.15.—Nuffield Universal tractor (35 B.H.P.)
(*Wolseley Motors, Ltd., Birmingham*)

large numbers during the war years. Another interesting feature is that the engine can be removed easily and replaced by a reconditioned one. This is always a strong point when considering the purchase of a tractor; for if anything should go wrong with the engine, it can be replaced by another very quickly, and the tractor need not be held up for lack of repairs to the engine.

A power-lift unit is mounted on the rear of the transmission housing and comprises a medium-pressure pump, control valve, and piston-operated cross-shaft which serve for the direct operation of rear-mounted unit-principle implements. In addition, however, a "*hydraulic power-plug*" enables middle, forward, or externally

mounted equipment to be operated, either separately or in conjunction with rear-mounted implements, whilst a simple addition permits *jacking up of the rear wheels* through the medium of the power lift. The lifting capacity of the power lift is approximately 3000 lb.

Power and To Spare.—One of the more powerful wheeled tractors is the " *LA* " *Case*. On very heavy soil or hilly land it is always an advantage to have a more powerful tractor, and the " LA " Case comes into that category. It is fitted with a four-cylinder vertical engine and the normal speed is 1100 revs. per minute. Three-bearing crankshaft and high-tension magneto with impulse

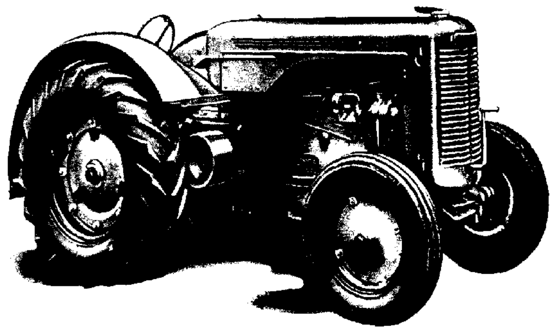


Fig. 1.16.—Model " LA " Case tractor (40 B.H.P.)

coupling for quick starting are other important features. Like other tractors it can be fitted either with steel wheels or rubber tyres, but rubber is certainly more popular. With a tractor such as the " LA " it is possible to do all the heaviest work on any farm, including ploughing, cultivating and threshing. It has ample power for pulling a standard 4 ft. 6 in. portable thresher between farms and, being fitted with a belt pulley, can also supply the necessary power to drive the thresher. It is also equipped with a power take-off shaft suitable for driving a binder or any implements on the farm where a power-shaft drive is necessary.

Simplicity, Economy, Durability and Power.—Although single-cylinder tractors are more or less condemned by many who believe that a single-cylinder tractor is unsuitable, most people will agree that Marshall Sons & Co., Ltd., Gainsborough, have been eminently successful in producing a single-cylinder tractor

(fig. 1.17). A single-cylinder stationary engine is different from a power-unit on a tractor. The stationary engine is set on a firm foundation, and has a far better opportunity of developing its maximum horse-power than a tractor which is out in a field and often on a very insecure wheel base. The engine of the Field-Marshall tractor is a simple-ported *two-stroke Diesel* unit so that there is no necessity for valves, carburettor, plugs, magneto or electric equipment. On this account a great many moving parts

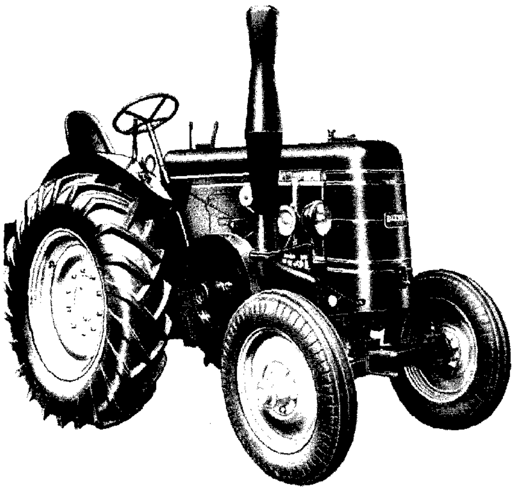


Fig. 1.17.—Field-Marshall Mark I tractor (38 to 40 B.H.P.)

have been eliminated compared with the generality of engines on tractors. The Marshall model incorporates a unique method of starting. It is by means of an explosive cartridge inserted in the head and fired by a trigger mechanism.

Marshalls have in production what are termed " Mark I " and " Mark II " tractors. Both are particularly useful for transport and capable of driving a 4 ft. 6 in. portable threshing machine fitted with self-feeder, chaff blower and buncher. They also have the power to pull a three- or four-furrow plough. The Mark II is fitted with a chain-driven winch which is capable of accepting very heavy loads.

With their simplicity of design, few wearing parts, power and economic consumption of fuel, these tractors are favourites with many contractors.

The Crawler for Pulling Power.—On many of the larger farms it is considered that a crawler type of tractor is most valuable. The advantage of this type over a wheeled tractor is that it will operate on any type of soil and hilly land. Figs. 1.18 and 19 show the Mark V.F. Diesel *crawler tractor* manufactured by John

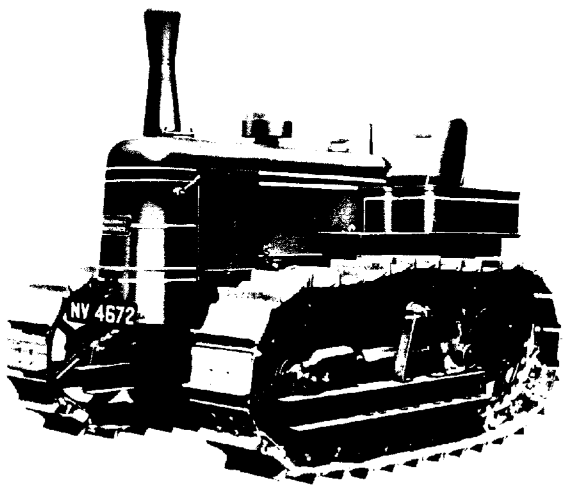


Fig. 1.18.—Fowler-Marshall Diesel crawler tractor (29 to 36 B.H.P.)

Fowler and Co. (Leeds) Ltd. This machine is fitted with a single-cylinder two-stroke Diesel engine giving 40 B.H.P. at the belt pulley. It is not only cheaper to run in comparison with a paraffin tractor of the same power, but it gives higher pulling-power under heavy loads. It also shows a very considerable saving in lubricating-oil consumption, as the oil does not require to be changed so frequently as in the case of the paraffin engine. Many of the crawler tractors are now built in such a way that the tracks are suitable for a certain amount of row-crop work.

Powerful, Compact Diesel Outfit.—The International Harvester Company was one of the first makers of *Diesel Trac-*

Tractors and is amongst the largest manufacturers of this type. A very wide range of this class of outfit is made by the firm. The engines are usually more easily started on petrol or paraffin and, after being warmed up, they are switched on to Diesel oil. On the heavier and more powerful tractors electric starting equipment is

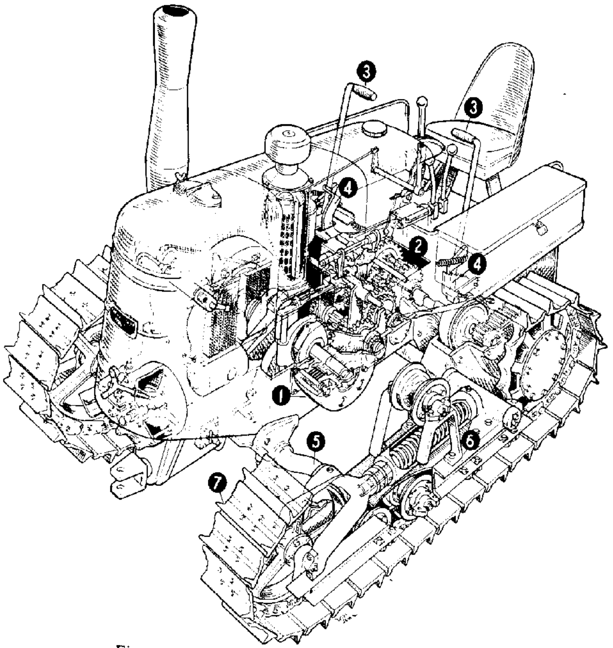


Fig. 1.19.—Fowler-Marshall Diesel crawler tractor
1. Engine clutch. 2. Gearbox. 3. Steering. 4. Brakes. 5. Front Suspension. 6. Track Frames. 7. Tracks.

provided. One of their most popular models for a medium-sized farm is the T.D.6. As will be seen from fig. 1.20 it is a compact medium-sized tractor, being just over 100 in. long. It can turn in short headlands, is fitted with five forward travelling speeds, and can be had in 40- or 50-in. treads with various shoe equipment. The total weight of it with 40-in. treads and 10-in. shoes, is approximately 3 tons. It has a four-cylinder Diesel engine, with a rated horse-power of 36 on the belt, and is capable of developing 29 h.p.

on the draw-bar. For belt work it is fitted with a 12¼-in. diameter by 8-in. face pulley, giving a speed of 811 r.p.m. It is also equipped with a power take-off at the rear, giving a speed of 862 r.p.m., but in addition it is fitted with a reduced-speed power take-off of 540 r.p.m.

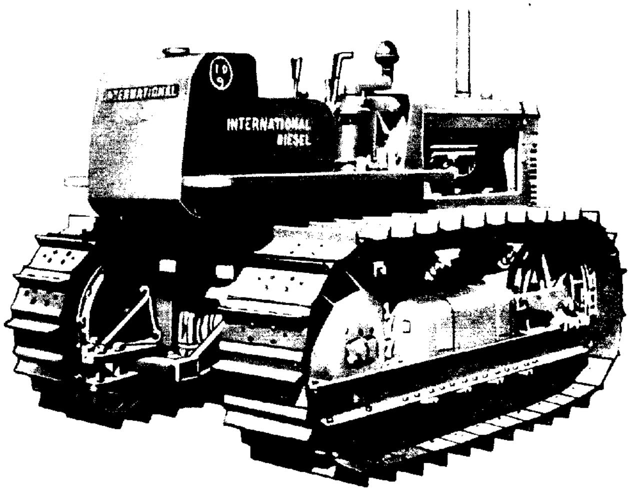


Fig. 1.20.—International crawler tractor (39 to 46 B.H.P.)

Comparative Speeds of Tractor and Horse.

Most modern advances are judged by the degree to which they have speeded up work and, naturally, the tractor's attainments have to be compared with those of the horse. In planning the day's or week's work, the efficient farm administrator must have an accurate mental grasp of what a tractor can accomplish in a given time. The old rule for horse work was that, for every foot width of the implement hauled, an acre of land could be worked in five hours. A similar formula serves very well for tractor operations. A medium tractor (suitable for two-furrow or three-furrow plough haulage) will give a coverage on field operations, corresponding to those accomplished with horses, of an acre and one-third in five hours, for every foot of width of the implement hauled. There is one operation, however, which does not lend itself to the foot-width basis for calculation. It is ploughing. In this task the tractor

beats the horse by a good deal more than one-third. It ploughs three times as much as can be done with a pair of horses.

It will be noted that in harrowing, rolling, drill seeding, &c., the tractor does not give quite the speeding-up of operations popularly associated with its performance. It is, however, when its general attainments are taken into account that its true advantages can be assessed. It saves time and man-power and it is tireless. Of course, even more impressive time and labour economies can be effected with the aid of the more powerful tractors operating on the largest farms in the homeland and abroad.

The Future.

It will be seen by the foregoing descriptive outlines of a few of many excellent modern tractors that we have travelled some way in the direction of improvements in design in the last forty-odd years since the Ivel tractor made its début, and the question most people will ask themselves is what room is left for further improvements. The whole history of mechanization suggests that there is no such thing as finality, and it is certain that tractor improvement will go on and on. What we may expect in the more immediate future, no doubt, will include, among other features, greater emphasis on reduction in engine weight, easy transfer of tractor engines temporarily on to other machines, and greater compactness and streamlining of general layout.

Electricity on the Farm

During the years which have elasped since Faraday invented the dynamo, the introduction of electricity into agriculture has been slow, relative to its widespread use in other industries. Farmers are no less enterprising than any other business men, and the fault for the slight use of electricity on farms can be laid, partly on the electric-supply undertakings, and partly on the prolonged uneconomic state of the farming industry. There were technical difficulties too, because for some time after electricity was in general use in towns the supply was always by *direct current.* The current had to be generated at the pressure or voltage at which it was to be used by the consumer, and the transmission of large amounts of power over a long distance involved heavy losses in the transmission cables. Only those farms which were not far removed from the main generating stations could be supplied with

power at a reasonable cost. With the general introduction of *alternating current*, so that pressure can be increased or decreased efficiently and easily by transformers, the distance over which power could be economically transmitted increased, and such undertakings as the *Clyde Valley Power Co.* and the *Ayrshire Power Board* in Scotland began to supply power outside the immediate neighbourhood of large towns.

With the development of the "*grid*" *system* in the 1920's large power companies were interlinked with one another at high voltage (132,000 volts), and from suitably selected points other supply lines at voltages such as 11,000 and 6600 were taken across country to form the basis from which individual rural loads could be supplied.

Another contributory factor, which had a bearing on the slow introduction of the general use of electricity, was that prior to World War I most Scottish farmers were tenants and were unwilling to spend large sums of money on improving landlords' properties without the assurance that compensation would be paid on waygoing. In England and Wales the position is even worse, for there is no legal obligation for a landlord to compensate a way-going tenant for the improvement of a farm by installing electricity. This has had a serious effect on the number of installations made by tenants.

Improved Financial Position.—It was not until about 1916 that farmers had enough capital available to meet the cost of an electrical installation, which was then considered by many as a luxury. The plants installed were all *low-voltage*, the prime-mover being a small engine or a water-wheel. These installations were in many cases not very satisfactory, the generating plants and battery storage being too small, while many troubles arose in the wiring systems, as electrical contractors had little knowledge of the unusual conditions and problems concerned with electrical wiring in farm buildings.

Small Engine-driven Generating Sets.—For many years now, however, one of the most popular investments on the part of advanced farmers in districts where there is no electric supply, has been greatly improved generating sets (fig. 1.21). Several makers produce units of various capacities, notable for their durability, efficiency and economical performance. These installations have wrought a wonderful change in conditions in farm-houses and in farm buildings.

Engine-dynamo sets are marketed at prices which compare favourably with those charged for other forms of equipment. The engines are of any horse-power decided by the extent to which it is intended to use electricity. They may be fuelled by crude oil,

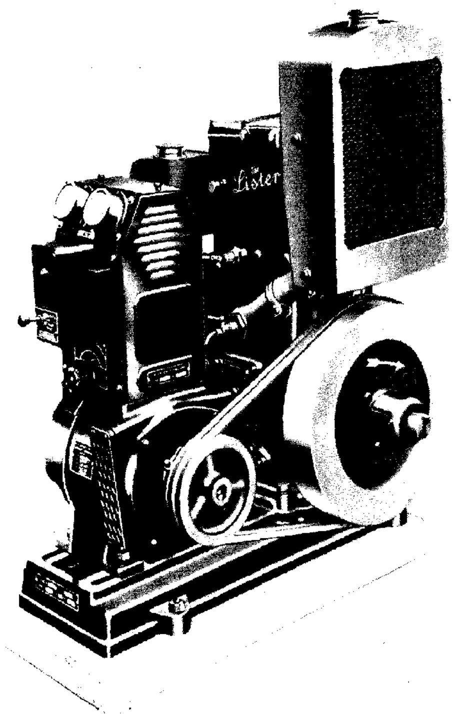


Fig. 1.21.—Petrol engine-driven generating plant
(R. A. Lister & Co., Ltd.)

paraffin, or petrol, according to the make of engine. A complete installation involves also batteries, wiring and lighting points. For a time farmers were satisfied if the installations supplied only light for the houses and steadings. Later, however, some of them introduced electric heating and small electric-driven machines for domestic purposes, all to be supplied by the same generating outfit.

For a set to provide only light a very small engine suffices, and, along with the batteries, does not trespass much on indoor space in the steading or outhouse.

There are still many farms remote from communal electricity supplies and on these holdings the small engine-driven electricity generating units prove to be a great asset in both house and steading. Electric lighting facilitates movement about the departments of the steading and makes labour much more easy; in modern farm kitchens and dairies electricity has revolutionized the work. What also is of no small importance is that the risk of fire, always great on farms, is much reduced in comparison with the old days when oil lanterns and lamps were the vogue, and had to be lighted with matches in gusty situations, amid highly inflammable materials.

But not until the grid system began to extend over the country could agriculture hope for a lightening of the heavy manual labour. As the grid extended there was no difficulty in getting farmers to take a supply, especially if the power lines passed near their farms.

Wide Range of Uses.—*Threshing plants* were among the first of farm machines to be converted from engine, or tractor, to electric drive, and the saving in time and labour was at once apparent.

There are many other applications of electricity of which *milking*, *cooling*, *sterilizing*, *water-pumping* and *heating*, *feed-cutting* and *grinding* are but a few. The increased cost of farm labour will further encourage mechanization and electricity will soon be regarded on the farm as essential. In most cases each farm machine will require its own motor, but where machines can be conveniently grouped, and have approximately the same power absorption, one motor with the necessary shafting and belting will result in a big saving in capital outlay. Machinery such as saws, elevators, &c., normally used outside may be driven by a "*transportable*" *motor* powered by means of a *trailing cable*.

The time, however, is not yet when every farm can have power from the grid system. This is mainly due to the supply mains not being within reasonable distance, but some power companies are anxious to develop low-voltage networks to link up blocks of farms, and the number of farms using electricity is increasing greatly.

Where it is possible, farmers should endeavour to obtain a *three-phase* in preference to a *single-phase* supply. This will inevitably result in a bigger cost for connexion to the mains, but, by

using three-phase motors, much simpler and less expensive motors and starters may be used.

In the future the success of many types of farming will depend on the use of electricity. The proper use of the various labour-saving appliances will result in running costs being reduced, and at the same time make for higher outputs.

There are about 50,000 farms in Britain already equipped with electric-power installations. Many more could enjoy at least the benefits of electric light if a little ingenuity were used to harness the *power running to waste* in streams, while the use of wind-driven generators of sizes suitable for supplying a large farm is worthy of some consideration. These are two domains in which progress has lagged far behind possibilities.

There is a big future for electricity on the farm in the heating of soil and the drying and other treatment of crops. It is quite possible that we can increase the productivity of our farms and get two crops per annum, where sometimes we have been hard put to it to get one. The "new deal" to farmers, in the shape of periodically adjusted prices for their produce, encourages the idea that such advances will receive a wide acceptance in farming practice.

The following table gives typical sizes of electric motors required: Threshing, 10–20 h.p.; grinding mill (new type), 3 to 12 h.p.; grinding mill (old type), 12–15 h.p.; chaff cutting, 6 to 12 h.p.; root cutting, 2 h.p.; cake breaking, 2–5 h.p.; hoist, 1 h.p.; water pumping, 1 h.p. upwards; milking machine, $\frac{1}{2}$–1 h.p.

Electric Fencing.

It was not until 1931 that the first *Electric Fence Controller* was marketed in America, and they were not introduced in England until five or six years later.

It consists of plain or barbed wire supported by light posts 20 or 30 ft. apart, and insulated on each post by a small porcelain insulator. One wire is required for cattle and horses, but two wires are needed for pigs and sheep. The wire is charged from an accumulator, or from the mains (fig. 1.22).

The shock from the electric fence is intermittent, approximately every second, and so gives a definite sting. The current during these shock periods, which are approximately one-tenth of a second, is limited for safety's sake, and it is advisable to make

sure that the electric fencer is well up to this limit in order to be effective. It must be realized that it is quite possible to give a shock that is dangerous to human beings and animals, and for this reason it is essential that farmers and others should not improvise their own fencing units or connect wires to the mains without a transformer.

Fig. 1.22.—Electric fencer unit
(Wolseley Sheep-Shearing Machine Co., Ltd., Birmingham)

Importing from America was stopped during the war. The fencer was then manufactured in England; it has steadily gained in popularity, and more and more farmers are realizing the advantages. The electric fence, although extensively used for the control of animals, for running along bared hedges or fences to stop up the gaps and more particularly for strip-grazing, cannot be termed a permanent fence. It is very useful for strip-grazing, but the method of strip-grazing has not been standardized, and the actual details will vary according to the locality and the rate of growth. If the fence is moved back every day so as to give a few acres of new grass

for a number of cows, that will be a suitable basis on which to work.

There is no doubt that farmers would benefit by the increased use of this very cheap and useful method of *temporary fencing*, which has been referred to by a well-known farmer as " a milestone in mechanization ".

Power Clippers—Boon to Sheep Farmers.

In few of the arts of animal husbandry has mechanization come to the aid of farmers more successfully than in sheep shearing and in the clipping of horses and cattle. While hand- or engine-

(" *Farmer and Stockbreeder* " photograph)

Fig. 1.23.—Portable electric sheep-shearing machine
(*Cooper-Stewart Engineering Co., Ltd., London*)

powered outfits share to the full in efficiency, in durability, and in precision of construction, it is the electric clippers which represent the last word in convenience of working and in economy of power used (fig. 1.23).

Electric clippers are available with a wide variety of power-units from which to select the particular type best suited to the

buyer's individual needs. They can be had in a form to rest on the floor or ground, on a portable platform, on a tripod, pendant from a bracket, or strapped on to the operator knapsack-wise. In all cases the compactness of the design is wonderful--light in weight and streamlined in the true sense of the term. The work of sheep shearing has been eased immeasurably, and some extraordinary feats have been performed in number of sheep clipped in a day by sheep shearers on some of the large sheep farms in Britain and overseas.

Fig. 1.24.—Wolseley " Clipkit " horse and cattle clipper

Out of clippers depending on other forms of power the electric machine, of course, developed, and the forerunner of mechanical clippers generally was one patented in 1877 by Mr. Frederick Y. Wolseley, founder of the firm of that name, whose products are esteemed in every part of the world. The original clipper was of simpler construction than the models of to-day, but it did its work and marked the birth of a boon to the industry of sheep farming. Where labour problems exist (and where do they not?) it would be impossible to maintain flocks in their present dimensions, especially in Australia and New Zealand, if it were not for the facility with which they can be clipped by machine.

Fig. 1.24 represents a machine known as the " Clipkit " for

clipping horses and cattle. It can be strapped to the operator's back and can be connected to an ordinary lamp socket with the required length of flexible cable. It has a universal motor suitable for alternating or direct currents. No vibration is apparent and its complete insulation ensures safety for the operator. Different plates are provided suitable for cattle or horses. Those who have electric fittings in their byre would never think of using a hand clipper when a machine of this type is available.

CHAPTER II

Tillage Implements

Ploughs

History of the Plough.

There are few who do not admit that "*if I had no plough, you would have no corn*". Ploughing is a fundamental necessity. Not only does it fill the stomachs of mankind, but the occupation of ploughing is an unimpeachable method of earning a living. It is an ideal way of life, replenishing the blood and mental vitality of peoples, and it has produced most of the world's greatest and most useful citizens. A Scottish schoolmaster once told his agricultural class that the ploughing occupation was central, and other callings were merely adjunctive or parasitic, the one or the other.

The implement itself, however, has to be used with never-flagging good judgment, and while the modern multiple-plough is employed for mass food production and mass soil improvement, ironically enough it has also proved its efficiency in making possible mass bad husbandry and mass soil erosion in certain parts of the world.

Mentioned in Old Testament.—Of all farm implements commonly in use at the present time, developed and perfected as they have been by the ingenuity and skill of agriculturists and manufacturers, the plough can claim the oldest and most interesting ancestry. By name it is quoted in the Old Testament, and in its various early forms it is figured on the ancient monuments in Egypt.

From accounts in sacred and in classical writings, it is possible to glean some information about the style and use of the plough amongst the Israelites, the Greeks and the Romans. At this early period it was a crude implement with a short beam, one handle, and a wedge-shaped body. Reference is made to a *coulter* and *ploughshare*, and from early drawings it is known that ploughs with wheels were used by the Greeks.

Even in those days there were various types of plough, for the Romans had one for stiff land and one for light soil. Others with two breasts are described as being used for ploughing-in seed, and one type with an adjustable board is mentioned.

Perhaps the most interesting reference to ploughs of these early times is made by the Roman author Palladius, who mentions two types, one simple and the other " eared ". " The latter," he says, " is used upon low and level land for laying up sown corn upon a higher furrow, in order that it may not be injured by the water standing upon it in winter."

The ploughs of the early Britons seem to have been even more primitive, and perhaps this was due to a law, said to have been in force, whereby no man should guide a plough until he could make one. The Saxon plough showed little improvement in design, but some are known to have been fitted with large *wheels*, and the draught arrangements were rather like those of the present-day farm cart. A plough of this type, as used at the time of William the Conqueror, is represented on the famous *Bayeux Tapestry*.

Horse Ploughing 900 Years Ago.—Over the period so far reviewed, oxen appear to be the only animals used to any extent for drawing the plough. They are, of course, still used extensively in many parts of the world as draught animals. It does not appear to have been recorded when horses were first employed, but it is thought that they were used by the Saxons, since the animal depicted with the plough on the Bayeux Tapestry is believed to represent a horse.

Both oxen and horses were subject to the cruel treatment of the use of the tail for drawing the plough. This practice seems to have been common until the seventeenth century, for an Act was passed in Ireland in 1634 which declared: " In many places of this kingdome there has been a long time used a barberous custome of ploughing with horses by the taile, whereby, besides the cruelty to the beasts, the breed of horses is much impaired in this kingdome ". It provided for punishment of offenders.

The ploughs of Britain down to the end of the seventeenth century continued to be clumsy tools used only for the purpose of breaking up the land to sufficient depth for seeds to be buried. No attempt appears to have been made to introduce any appreciable improvements either in the design of the plough or the performance of its work, although in 1677 a notice occurs of an effort made by a young man of Kent to work two ploughs fastened together,

by which means he ploughed two furrows at once, one under the other, and so stirred the soil to 12 in. or 14 in. in depth.

It was early in the eighteenth century before a plough was designed which bears resemblance to its modern counterpart; but thereafter progress was steady, at least in the countries where agriculture was advanced.

Dutch introduced Iron Facings.—The Dutch are credited with having introduced into this country about the year 1730* the first plough, the design of which led to the type of plough that is generally known to-day. It was made and improved at Rotherham, and although constructed chiefly of wood, included new features, such as draught irons, share and coulter, with the additional plating to the wooden mould-board and sole, all of which were made of iron; but perhaps it was the celebrated *James Small*, a Scot, who constructed in 1740 the first plough on truly mechanical principles. He is said to be the inventor of the "cast-iron turn-furrow", and J. Allen Ransome in his classical work *The Implements of Agriculture* says "Small's plough may, in most respects, be referred to as a standard for the elements of plough-making".

It was in 1763 that James Small established his Plough and Implement Works at Black Adder Mount in Berwickshire, and from his original plough was developed what is known as the "Scotch" plough, which comprised the improvements made by him, but instead of wood, *the beam and handles were made of iron.*

Compared with Small's first effort, the Scotch plough as developed by such famous Scottish pioneers as Wilkie, was a graceful implement of very clean design.

At the same time, ploughs of the "Rotherham" type were being made in various parts of the country. Being of wood and iron, they were invariably a joint production of the blacksmith and wheelwright; but it would appear that according to the likes and dislikes of the various plough-makers, it was altered to suit local conditions, and consequently there were a great many variations of the Rotherham plough. Its wooden construction led others to take steps to overcome its vulnerability when exposed to soil and weather, and also repairs, and Arthur Young in his "Agricultural Report of Suffolk" (1804), wrote of a Suffolk blacksmith named Brand, who, many years previously had constructed a *plough wholly of iron.* It had a novel "cops" or head of his own

* Engineers from Holland came to this country about this time to drain fen land, and it is thought that they were responsible for the introduction of this Dutch plough.

invention, and he further states " There is no other in the Kingdom equal to it ". Incidentally, the " cops " referred to closely resembles the type of *hake* to give vertical and lateral adjustment to the line of draught, such as is used at the present time.

A Vital Innovation.—The inventions of *Robert Ransome*—the founder of Ransomes, Sims & Jefferies, Limited—brought great changes to plough design. In 1785 he patented the *tempering* of shares made of cast iron, by the aid of salt water, but this was followed by a far more important invention, for in 1803 * he discovered and patented a system of *chilling* the under-surface of cast-iron shares, overcoming the great difficulty which had hitherto

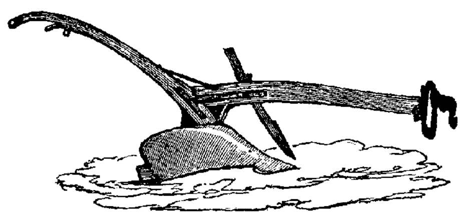


Fig. 2.1.—An old-time Suffolk swing plough

been experienced with shares of this type. By this invention a type of ploughshare was introduced which had an underside as hard as steel. The upper part, which was soft, but tough, wore away more quickly than the lower part and left the edge always sharp. The importance of this invention will be fully appreciated when it is realized that previously the shares in use on ploughs were mostly wrought-iron ones, which were not only more expensive, but necessitated frequent journeys to the blacksmith for re-setting and repairs. The introduction of what is to-day described as the " self-sharpening share " decreased considerably the draught for the horses, and at the same time improved the quality of ploughing, because, although remaining sharp, its pitch was also maintained, and in consequence the depth of ploughing was consistent all the time the share was wearing.

Handy Replacements.—These inventions were followed by

* The circumstances of Robert Ransome's invention, as they are handed down in the annals in the possession of Ransomes, Sims & Jefferies, are very interesting. It would appear that one day when Robert Ransome was breaking up waste iron which had spilled from the ladle on to the foundry floor, he noticed the structure of one piece of metal which had fallen on to a cold iron plate. This piece of metal revealed a hard white skin on the side which had been in contact with the cold plate.

further improvements, making it possible *to replace the common wearing parts quite easily without having to remove the plough from the field. A plough of this type was the subject of a further* patent by Robert Ransome in 1808, and the plough body he constructed at this time incorporated features which are common practice amongst plough-makers to-day. The ploughs of Robert Ransome, so improved by these inventions, were sent to all parts of Suffolk and the adjoining counties, and although almost a century and a half has elapsed, the present-day horse plough remains basically the same; the alterations which are apparent being chiefly concerned with manufacturing technique.

An Acre a Day.—The part which the agriculturist played in the improvement of ploughs is often brought to light in agricultural books. Both educative and amusing incidents are related of the efforts of farmers to further the efficiency of agricultural practices. In the book by A. M. W. Stirling, *Coke of Norfolk and his Friends*, which deals with the life of the famous Norfolk agriculturist, reference is made to a competition between him and Sir John Sebright, M.P. for Hertfordshire, which is recorded in the following manner:

"Sir John Sebright offers to bet 50 guineas that Mr. Coke will not plough an acre of land in one day in a husband-like manner with the wheel-plough commonly used in Norfolk, with two horses; an acre of which Sir John Sebright will plough in the same time with a Hertfordshire plough and four horses; the land to be fixed upon by Sir J. Sebright, near Beechwood, in the month of October. One person to be named by each of them and they calling in a third if they do not agree."

As might be expected, Coke's plough accomplished the task in the agreed time, and the only question to be decided was whether it had been performed in a husband-like manner. The Duke of Bedford, under whose roof the bet was originally made, satisfied himself as to the quality of the work.

It should be explained that Thomas Wm. Coke had previously proved his Norfolk plough, old-fashioned though it was, to be an improvement on other types, such as the one used by Sir John Sebright, for in 1784 he made a present of a Norfolk plough and a pair of Norfolk cart horses to a friend in Gloucestershire, after being astonished at seeing "six horses at length turning a single furrow with a clumsy plough, and making hard work of it". The Norfolk plough with two horses made excellent headway, the work was well done and the horses were not tired out by the task.

Scottish Improvers.—The pioneer work of leading Scottish agriculturists in the early part of the nineteenth century, as mentioned in Stephens' *Book of the Farm*, is interesting, since it records the introduction of the digging plough. In 1849, the *Marquis of Tweeddale*, on his farms at Yestermains, developed a plough which is described as being " capable of taking a furrow slice 12 in. wide and 13 in. deep in the most effective manner ". The " Tweeddale " plough, as it was known, was a big advance from the old Scottish plough, for the remark is made that " no implement has approached the point to which this has attained for enlarging the extent of the surface exposed to the atmosphere ".

It was the interest which the Marquis of Tweeddale showed in *subsoiling* which appears to have resulted in the introduction of the Tweeddale plough. Subsoil ploughs had been introduced as early as 1829 by *James Smith of Deanston.* Another development was carried out by *James Slight* of Edinburgh and a *James Read.* The ploughs were designed to work in the open furrow behind the ordinary plough, so as to stir up the lower soil, but there was not much room to work in the open furrow provided by the ordinary type of plough. The *Tweeddale plough* opened a furrow sufficiently wide for the passage of an improved subsoil trench-plough of his own design, and it is said that the effect of the resultant deeper system of cultivation improved the value of the land from 7*s*. or 8*s*. per acre to £2 per acre.

" Unbroken " and " Broken " Furrow Ploughs.

When the variations in soil and climate in this country are considered, it is easier to understand why the development of ploughs during the eighteenth century has resulted in the introduction of many varieties in design. The variations have been chiefly in connexion with the plough body, where the shape of the share and breast have been altered to provide the type of furrow slice each particular district demands. In areas of heavy clay land, where ploughing is effected in the early winter so that it can " weather " and be more easily worked in the spring, the bodies have been designed for turning over an *unbroken furrow slice.* Invariably in such districts the cultivated soil is comparatively shallow, and it has been necessary to rely entirely on the breast to turn the furrow slice so that the surface growth is thereby buried.

In districts where the soil is of a lighter nature and more easily worked, the development has been towards the introduction of

shorter and more abrupt breasts which turn the furrow more quickly and leave it broken. Often such soils are deeper and the skim coulter has been introduced to bury the surface roughage. It must also be remembered that until such pioneers as *Jethro Tull* introduced the machine for sowing seeds, the farmer broadcast his seeds on the seams left by the furrow slices, and this is why so much thought and care was given to the design of plough breasts that would cut a narrow but deep furrow, which could be laid up firmly to the previous furrow to leave no holes for seed to be lost. To this day there are districts in Britain where farmers with small arable acreages plough with horses and do not possess a modern seed drill. They plough a 6-in.-wide furrow and sow their corn by hand on the face of the ploughing.

As was mentioned earlier, the development of ploughs was much in evidence in countries where agriculture has been scientifically studied. Throughout this time there was great progress in Northern Europe and on the American Continent. On the other hand, in lands where agriculture is only practised as a means of sustenance for the peasant or native, the ploughs used are very little altered from those employed hundreds, if not thousands, of years earlier.

In the foregoing outline of the evolution of the plough will have been identifiable the main stages in the vast span of improvement that reached from the primitive stick used to stir the soil up, to the period when horse-power, and later tractor power, made possible the employment of multiple-furrow ploughs.

Multiple-furrow Ploughs Stand Between Us and Hunger.

Taking the present-day world-wide campaign to step up arable-crop production to feed a population that has 15,000,000 additional mouths to satisfy every year, it is the *multiple-furrow principle* in plough construction that is making the gigantic, intensive farming plan feasible. The tractor, of course, has enabled us to capitalize the advantage of the multiple furrow to the full. At the same time we must not forget that more than half a century ago the virgin soils of the prairies were being put regularly into crop by ploughs turning many furrows simultaneously and hauled by large teams of horses. In Britain, ploughing by steam engines incorporated the multiple-furrow plough. To-day, however, tractors and the multiple-furrow ploughs combined (fig. 2.2) form the spearhead in the battle to save the world from hunger.

In Britain we need carefully carried out ploughing; slipshod methods will not do. It does not need to be fancy work, but it must bury adequately surface material, which may include weeds. In many lands overseas, however, the same care is not considered essential and this has led to the use of some types of ploughs that are not favoured in British practice. The multiple-disc ploughs, for instance, would not suit average conditions here, especially on marginal classes of soil.

The great push to extend our cropping area has compelled us to make increasing use of a type of plough much employed in America and Canada—the *single-furrow tractor plough* (board- or

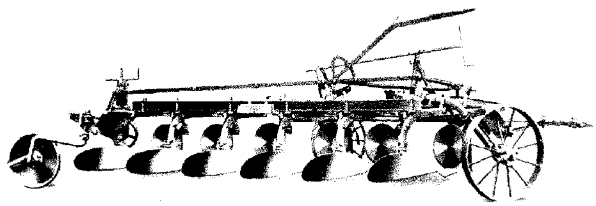


Fig. 2.2.—" Hexatrac " six-furrow plough

(*Ransomes*)

disc-equipped) turning a huge, broad furrow—to bring into cultivation rough land, heathland, cleared woodland or coarse marginal tracts. This, however, is taking us rather away from the subject of multiple-furrow types.

Two-furrow horse ploughs were used in the past, but were never very popular until the tractor began to come into its own. On medium-sized places the two-furrow plough is most popular (fig. 2.3), but on larger farms three- or even four-furrow units are often seen. In the earlier stages tractor ploughing was looked on askance by many farmers. It was only after a great deal of care and attention had been given to the even setting of the plough, so that the furrows would be of uniform size, that the tractor really met with favour for ploughing. The tractor driver had to keep a straight line to give the best results. Another important point that was overlooked by careless drivers of tractors was the turning—the releasing of the plough at the headlands and also the re-entry.

This required skilful manipulation to make a thoroughly tidy job.

Now that many tractors have *close-coupled ploughs* (fig. 2.4) and implements, they can make as good a job as the horse plough and the single-furrow plough. I believe that very soon all ploughs will be close-coupled to tractors and that on even the *smallest farm or croft* the work will be done with a light tractor and a single-furrow or two-furrow plough. The cost of having the work done by tractor is certainly much less than by horse haulage, in spite of a fairly heavy depreciation on the tractor, and the fact that the horse's food is produced on the farm.

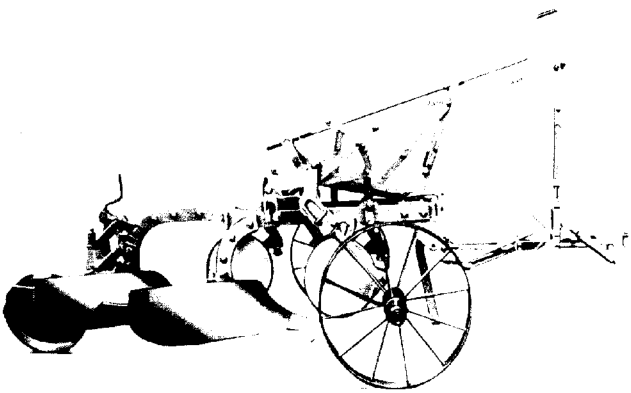


Fig. 2.3.—"Midtrac" two-furrow plough
(*Ransomes*)

Many types of two-furrow tractor ploughs have been built, but the range is now narrowing down to a few of the larger and better-known makes. I think it is to the advantage of farmers that it should be so, as it saves agents, distributors and manufacturers having to carry excessive stocks of different spare parts.

Ploughing costs are a trifle fluid owing to changes in wages, plough prices and tractor prices from time to time, but should not work out at over 5*s*. per hour or 16*s*. per acre on fair-sized farms. A tractor two-furrow plough, on a medium soil, should turn over three acres in a day of nine hours and use roughly three gallons of fuel per acre. Three-furrow plough performances are pretty much in proportion.

Fig. 2.4.—The mounted plough
The plough is lifted by the hydraulic power lift mounted on the tractor
(Fordson Major Tractor and Ransomes Plough)

The Economical Mole Drainer

In many parts of the country it is unfortunate that the land is not so dry as it might be, and draining operations have to be carried out extensively. Using a *mole drainer* is a much cheaper way of draining the land than by excavating a few feet deep, putting in drain pipes and filling in the earth again. Fig. 2.5

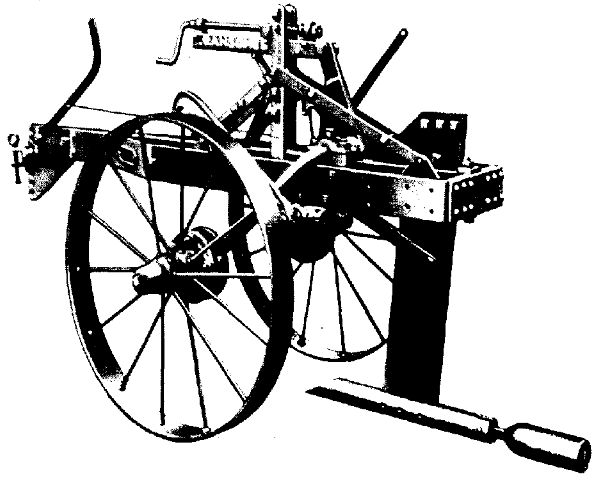


Fig. 2.5.—Mole drainer (*Ransomes*)

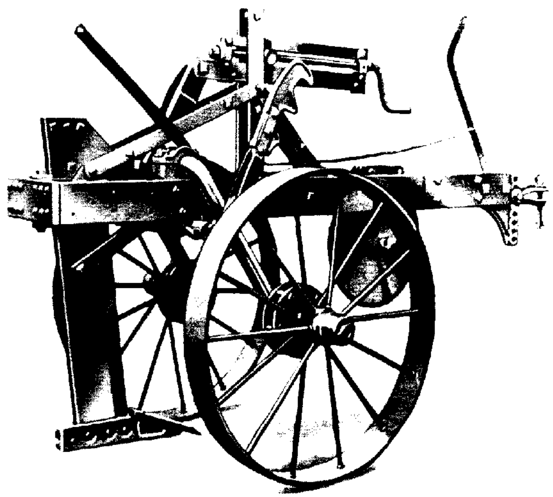


Fig. 2.6.—Mole drainer with subsoiling point and shoe fitted in place of mole (*Ransomes*)

shows a mole drainer which can be used not only for draining, but also for *subsoiling*. This implement is built to make a 3-in. diameter opening, but by having an extension at the rear of the mole it can produce an opening of 3½-in. to 4-in. diameter. In this way the main drain can be made larger than the subsidiary drain leading into it. It can work down to a depth of 20 in. As a subsoiler, a subsoiling point and shoe are fitted in place of the mole (fig. 2.6). A disc runs in front of the mole and severs the turf through which the " blade " follows.

Cultivators

Will Tractors lead to Cultivator Standardization?—It is probable that if a separate museum for each class of implement of husbandry used down through the years in Britain were arranged, that for cultivators would equal in dimensions those for all the other implements put together. A " cultivator " was, and is, a flexible term. Big engineering firms vied with each other in endeavours to bring in a change for next year's shows. Every one of them produced a few models at a time. The farmer with heavy clay land had his special needs. So had the man operating on open, free loams; the stony-land farms presented another problem, while places with steep fields needed different outfits. On top of that, many small firms and even parish shoe-smiths, in catering for some special local preference, added their quota to the diversity in design. That was so even in the days when there was nothing but horse haulage. There were cultivators with wheels, with no wheels, with a shaft between the horses, or with no shaft, with means for lowering and elevating the implement, or without it, and with rigid tines or with spring tines. The coming of the tractor naturally has further taxed the accommodation of our " museum " and, at the moment, indeed, despite the obvious advantage of standardization, we have still a bit to go in that direction.

For tractor haulage one of the most popular cultivators is the " Dauntless " (fig. 2.7) (Ransomes, Sims & Jefferies, Ltd.). It can be fitted with solid spring-mounted steel tines for rocky ground. The tines are interchangeable and the two outer ones completely cut up the wheel-track where ample clearance is provided. It is an implement of some versatility and, while the standard points used are intended for ordinary cultivation, the wider ones are for

scarifying or destroying weeds. The Dauntless is fitted with a self-lift which can be easily operated by the driver from the tractor seat. It is strong and rigid enough for cultivating light or heavy soils.

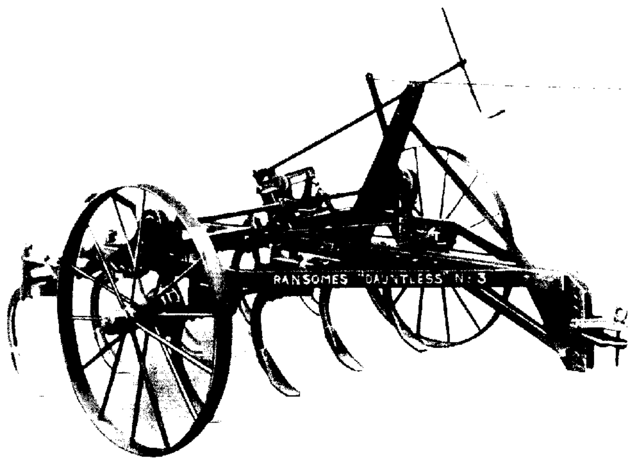


Fig. 2.7.—" Dauntless " cultivator (*Ransomes*)

Rotary Tiller Excells in Spring.

One of the greatest labour-saving machines yet introduced for tillage operations is the *rotary tiller*. It can do to perfection, in one operation, the work of the plough, cultivator and harrow. Although it can dig up lea and stubble land to the required depth, it is unsuitable for certain kinds of work in the autumn, because it is inadvisable to leave the land flat and in a fine tilth through the winter. It is, however, unsurpassed for spring work, such as the preparing of turnip land, and it is also specially suitable for the cleaning of dirty soil. Machines of this type, but of a smaller size, are used with great advantage in nurseries and market gardens (fig. 2.8).

The rotary tiller has its difficulties in stony land. Because of the high speed at which the tiller rotates many of its blades or fingers can be badly smashed in coming in contact with hidden stones.

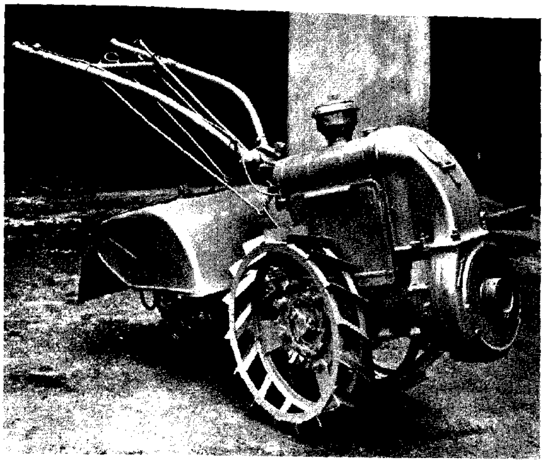


Fig. 2.8.—" Rototiller" rotary cultivator
(Geo. Munro, Ltd., Waltham Cross)

Harrows

Harrows follow the Plough.—Although tractor-hauled harrows are beginning to monopolize the attention of designers, makers and users, there is an interesting and useful background for study in the wide range of harrows of simple construction, for horse haulage, that have been used down through the years. In olden times, on lighter, open soils, types were used that were made with wooden frames and wooden tines. Before the horse-haulage outfits became universal, harrows were pulled by oxen and sometimes by persons. As the use of iron became more common, wooden tines disappeared and, even for the frames, iron became the normal material employed in construction. In horse-harrow practice there were two kinds used. One type was the general-purpose harrow for preparing a seed tilth, freeing weeds from loosened soil, and covering cereal seeds that had been broadcasted. The other design of harrow, close-tined, short-tined, and of light weight, was for covering in thoroughly, but not too deeply, grass seeds.

In approved practice, harrows used on stiff soils were much stouter in construction, and were heavier, to give them the degree

of penetration called for on clayish land. A third type of harrow, that did not come into general use, revolved horizontally about an axis and did excellent work at a given pace. Harrowing with ordinary horse-haulage types was a fairly speedy operation, a two-horse outfit covering the ground at the rate of 2 acres per hour, or over, according to the overall width of the set.

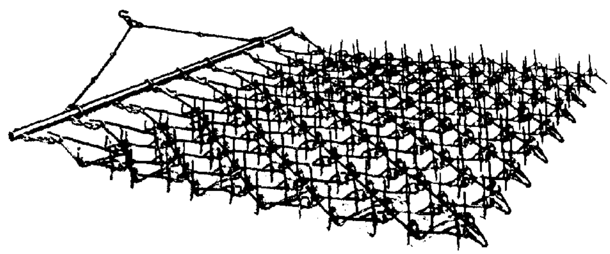


Fig. 2.9.—Double-tine flexible harrow
(*Wm. Aitkenhead, Ltd., Oldham*)

One of the more modern innovations is an improved type of double-tine harrow (fig. 2.9), which is fitted with a *long tine* for general arable work and for dealing with moss or fog grass in pastures, and a *short tine* for breaking up and spreading manure, or mole hills. If the land has been gone over once, and possibly twice where it is very bad with fog, the new fresh grass, in many cases, is surprisingly good. After the fog harrows have been used,

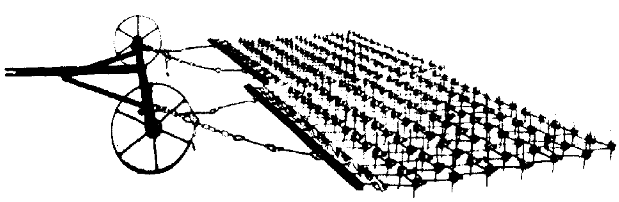


Fig. 2.10.—" Light Ripper " harrow (*Aitkenhead*)

say, twice, it is advisable to apply a little fertilizer. The result will more than repay the outlay.

Another type, the " Light Ripper " (fig. 2.10), is very useful where a lot of heavy work has to be done, and this weight of harrow is necessary for tractor use. The links are made of heat-treated spring steel and the tines are of high-carbon steel, sharpened and hardened at the points. The tines are rigidly secured by means of malleable iron clamps and a stay-bolt on which are formed inclined faces, so arranged that, by tightening up the nuts, the link and the tines are rigidly wedged together, thus forming an extremely strong construction. This layout also ensures that the nuts do not become loosened, that the tines will retain their correct angle and that they can be quickly removed for resharpening. The harrows are reversible and, having long tines on one side and short on the other, they are suitable for either grass or arable work.

The Efficient Disc Harrow.

Next to the plough the *disc harrow* is the most valuable of machines in preparing the soil (fig. 2.11). First used in America

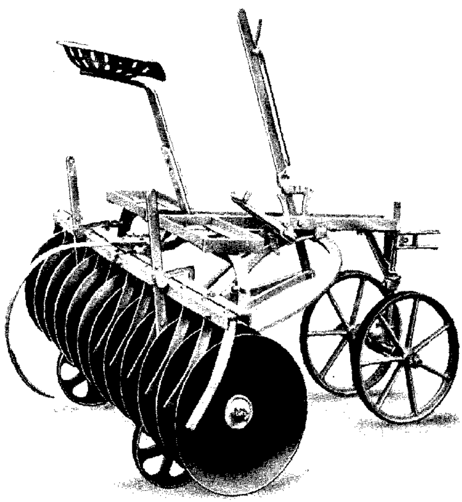


Fig. 2.11.—Single-horse disc harrow
(*Walter A. Wood Co., Ltd., Horsham*)

as early as 1857, it was not until some fifty years later that it was extensively used in Britain. This implement is made with various sizes of discs. Single discs for horse draught are usually about 5 ft. to 6 ft. wide and 16 in. diameter. Where a tractor is employed the discs are usually 18 in. and 20 in. diameter. It is considered that the larger disc is more effective for breaking up the soil and making a finer tilth. Tractor disc harrows are made

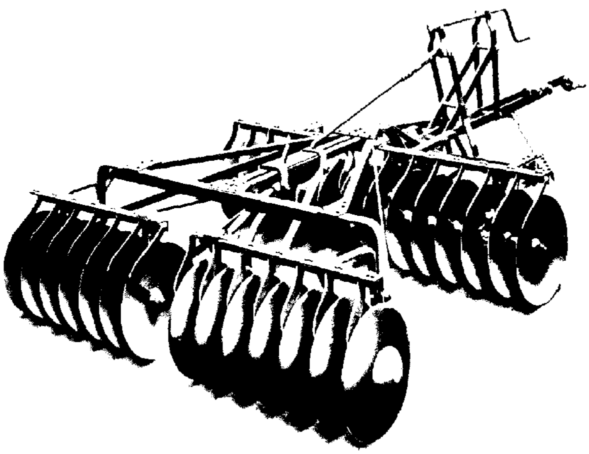


Fig. 2.12.—Tractor tandem disc harrow
(*Ransomes*)

of various sizes from 6 ft. up to 9 ft. and they work in tandem, as illustrated in fig. 2.12. For the breaking up of old lea pastures and for burying seed grain, the disc harrow has no equal. It is an implement that should be on every farm.

Spring-tooth Harrows.

A rival to the disc harrow is the spring-tine cultivator (fig. 2.13). It is by no means a newcomer to the list of farm implements. On many farms, where they were used and discarded many years ago, they are again coming into use. They are more effective for making a seed bed than the ordinary rigid-tined harrow and, where the seed grain is broadcast instead of drilled, the spring-tined cultivator is exceedingly useful for covering up the grain.

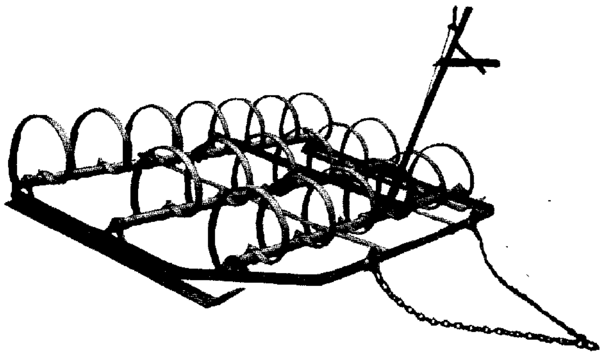


Fig. 2.13.—Spring-tooth harrow
(Barclay, Ross & Hutchison, Ltd., Aberdeen)

Chain Harrows.

Chain harrows proper have changed less in design than have most implements and are used principally for the rolling of weeds into bundles to make them much more easily collected than they would be when lying scattered. On moderately friable soils they produce a finer tilth than any other piece of equipment. The harrows consist of a complete set of links, all knitted together. Quite a popular size is 7 ft. 6 in. wide by 8 ft. 6 in. long (fig. 2.14). Many users believe in having their chain harrows made in two halves, the first half having heavy links for breaking down clods

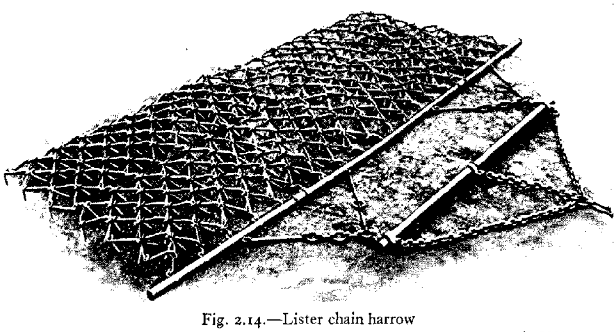


Fig. 2.14.—Lister chain harrow

and the second half being made lighter for rolling the weeds. With a tractor a much wider harrow or two sets of harrows linked together can be used with advantage and saves a lot of time.

Land Rollers

After ploughing and sowing it is most essential, need it be said, to have a *land roller* for breaking up clods and for levelling the soil. The first roller used was the trunk of a tree; next came the stone roller and on some farms these are still in use, particularly in the Highlands of Scotland, where there are small farms and crofts.

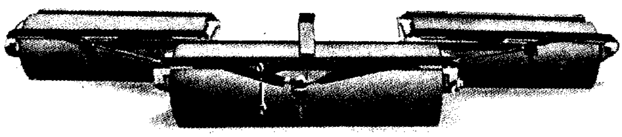


Fig. 2.15.—Cast-iron flat-cylinder tractor roller
(*G. C. Ogle & Sons, Ltd., Ripley*)

The majority of rollers used now are of cast-iron or of steel and vary in size from 18 in. to 30 in. in diameter. Fig. 2.15 shows the cast-iron flat-cylinder tractor rollers which are most popular in Scotland. They vary in size from 18 in. to 30 in. diameter, and those used for horse draught are mostly made in two cylinders each 3 ft. long, and about 20 in. diameter. For tractor use they are made up in sections, and vary in width from 16 to 18 ft.

In England the *Cambridge* type of *roller* is generally used. It is built up in three sections, which vary in width up to 6 ft. The sections can be used singly with horses. The Cambridge type does not leave so smooth a surface as does the flat-faced roller, but it is more effective for clod crushing (fig. 2.16).

To get the most efficient results, land should never be rolled when it is too wet. The smooth surface that is obtained by the use of a heavy set of rollers is a great advantage in harvest time, as it eliminates a great deal of unnecessary vibration in the reaper and binder and, in many cases, saves breakages. For transportation

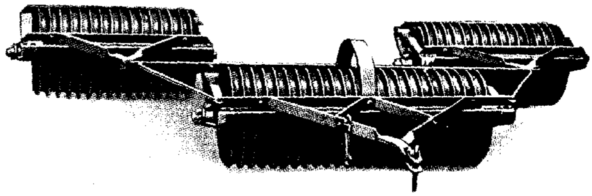


Fig. 2.16.—Cambridge tractor roller
(*Ogle & Sons, Ltd.*)

on roads and through narrow gateways it is necessary to have gang-rollers disconnected and attached behind each other.

It is generally agreed that heavy rolling of crops helps in the destruction of wireworm. The rolling is sometimes done two or three times and, although it may have a detrimental effect on the crop, this is far outweighed by the amount of good it does by killing off the wireworms.

Seed Drills

From time immemorial, up till a few decades ago, grain was sown by hand, but the operation duly became mechanized by the introduction of **broadcast sowing-machines, coulter drills,**

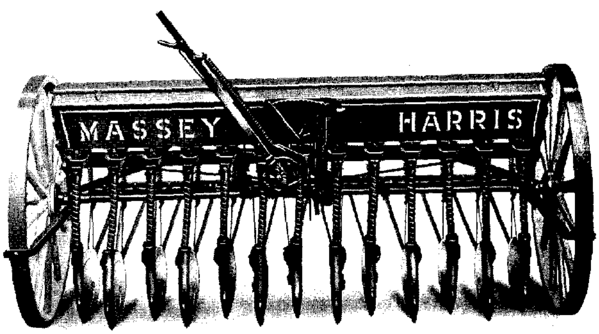


Fig. 2.17.—Seed drill (*Massey-Harris, Ltd., Manchester*)

and now by disc drills (fig. 2.17). They are made of various sizes for horse and tractor draught. The grain is fed by a multiple-gear disc on the main axle, in conjunction with a sliding pinion, which is controlled by an index lever, which regulates the grain release. When the grain is thus set free it passes through spring-steel spiral tubes. These tubes are highly flexible and can be moved quite easily without any damage whatsoever. A good drill should have a particularly strong frame with broad wheels so that they do not sink in soft land. A wooden wheel is preferable to a steel or metal one, as it has deeper sides to its rim, and thus does not collect soil beside the spokes. All drills have an attachment for registering the acres sown.

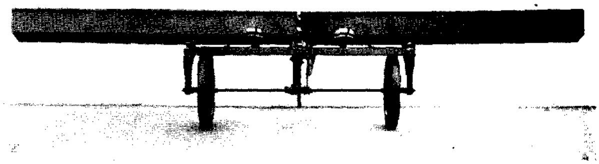
Too wide spacing between the discs is not to be recommended because, unless the soil is very deep, weeds tend to come up between the drills. Some farmers overcome this danger by double sowing in a transverse direction.

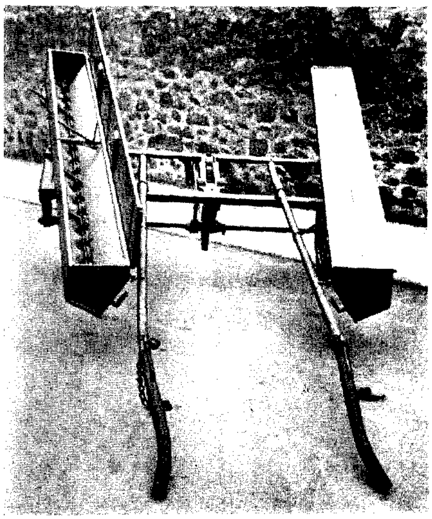
Broadcast Sowers for Speed.

Before *broadcast sowing-machines* were introduced, oat and grass seeds were sown by hand. The broadcast sowing of oats, barley and wheat is much more common in Scotland than in England, the reason being that many farmers consider that the broadcast sower could accomplish the work in one-quarter of the time of the *coulter corn drill.* In latter years, however, in many instances the coulter corn drill was superseded by the *disc drill.* With either of these two drill machines the seed is deposited in rows at a uniform depth. A broadcast sowing-machine, however, is still very necessary (fig. 2.18). If not used for grain, it is essential for sowing grass and clover seeds. For distributing a very small quantity of grass and clover seeds over an acre, the broadcast sowing-machine must be set with strict accuracy. The seed is put out by small pinions, revolving along the bottom of the seed container, and the openings must be correctly set so as to give an even spread over the soil of the small quantity of seed which has to be sown.

Most of the machines are made with two folding containers, or compartments, each covering a width of approximately 9 ft., giving an overall width of 18 ft. The two units rest on a wooden or steel frame and, for the convenience of transport along roads and through gateways, these boxes fold inwards. The machine illustrated has an in-and-out gear attachment and, by moving this,

sowing can be stopped immediately. Broadcast sowers can be fitted with either wooden or wrought-iron wheels, but wooden wheels, as already noted, are preferable, since they are not so liable to lift the soil when travelling on soft land.





Folded for transport

Fig. 2.18.—Broadcast sowing-machine
(Geo. Sellar & Son, Ltd., Huntly)

Planting Machines

Potato Planter.

The *potato planter* (fig. 2.19), like the transplanter, has done much to save labour. There are now planters which can do ridging, sowing of fertilizers, planting and covering-in the potatoes all in one operation. The fertilizer container is placed in position above

Fig. 2.19.—" Robot " potato planter
(Transplanters (Robot) Ltd., Sandridge)

the potato-planting hopper. The fertilizer can be dropped in front of the ploughs and is " split " by them. It is then ridged up over the seed by the rear discs, thereby being evenly mixed with the soil.

Another method is to insert the delivery spouts into the hollow centres of the " plough shoes " and the fertilizer can then be deposited below the seed. The machine shown is capable of planting between the rows from 27 in. to 29 in. apart, depending on the

width apart that the grower wishes the drills to be. The container of this machine has a capacity of approximately 2 cwt.

The seed from the hopper is regulated by gravity-fed shutters according to size, and runs from the hopper into the shaped tray at its base. In this position the feeder has little difficulty in transferring the potatoes to the cups on the rotor, and from there the potatoes have only a few inches to drop into the furrows. Although the seed differs greatly in size and type, a very regular spacing is maintained. It has been proved that this machine can plant sprouted potatoes without damage to the tubers.

Transplanters are Great Labour-savers.

The range of agricultural machinery could not be regarded as complete without such a machine as the "*Robot*" *transplanter* (fig. 2.20), for swedes, mangolds, beet, cabbage, kale, and other small plants. This piece of equipment is one of the greatest labour-savers of all the machines that have been invented during the

Fig. 2.20.—" Robot " transplanter
(*Transplanters (Robot) Ltd.*)

last thirty or forty years. So much labour is needed for the planting of vegetable crops that a machine, operated by five girls, which can do the work of approximately twenty skilled men, is certainly a tremendous asset to a farmer or market gardener. One of the many things to recommend it is that it can be fed by unskilled labour, boys or girls, as the mechanical fingers will handle almost any of the plants without damage or injury whatsoever. Another point to recommend it is that the distance is automatically regulated, whereas by hand planting this is not always the case.

The transplanter opens a broad furrow of even width and adjustable depth wherein the roots are deposited. A continuous moving chain of rubber-clad grippers places the plants in the open furrow with the roots suspended in their natural position. The grippers, being rubber-clad, do not injure the plants, which are placed evenly along the furrow. Immediately the plants are released the angle pressing wheels of the machine close the furrow with the soil round the roots. Set in this way the plants have a far better chance of establishing new growth than have others dibbled in by hand.

Fertilizer Distributors

Artificial fertilizers are being used more and more extensively every year. These fertilizers vary from highly concentrated chemicals, of which small quantities are spread on the area, to the lower-grade mixtures involving much heavier dressings on the same area. Before mechanical distributors were invented the fertilizers were carried in a hopper by the worker and sown by hand, a practice which still prevails on some small farms.

Fertilizer distributors are of many different designs and types and, because of the detrimental action of the chemicals on the metal parts of these machines, they have a very short life. The design of the machine depends both on the texture of the fertilizer and on the intended rate of distribution.

In the *Bamford distributor* (fig. 2.21) the sowing apparatus consists of a fixed grid at the bottom of the hopper, above and below which are two reciprocating plates, each having a number of slots. As these plates move backwards and forwards they allow the fertilizers to fall through in a steady stream. Each of the movable plates is divided into two parts, each of these two sections being operated by a connecting-rod attached to an eccentric, which is

actuated through bevel gearing from the forward motion of the road wheel. When more concentrated fertilizers were introduced it became important to give accurate and economical distribution, and the makers of this machine have gone a long way to meet this demand. It has also special attachments for sowing in drills as well as on the flat and, to get the wheels to run in the furrows, or between the rows of growing plants, an extended axle can be fitted. The manufacturers have been careful to choose *anti-corrosive* materials which obviate cleaning, and the machine is more easily dismantled.

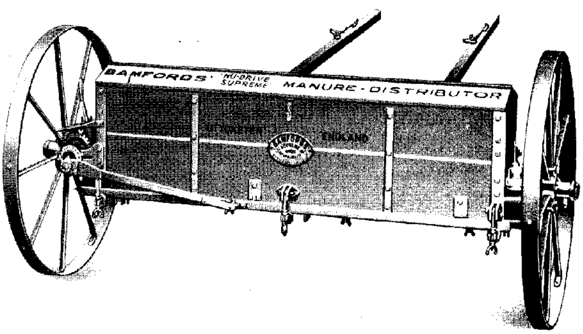


Fig. 2.21.—" Nu-drive Supreme " fertilizer distributor
(*Bamfords, Ltd., Uttoxeter, Staffs.*)

" **Wave Disc** " **Manure Distributor.**—One of the first, and simplest, types of artificial-manure distributor is a machine with revolving discs in the bottom of the container. It has a row of discs which revolve round a shaft; they cover and uncover the opening in the bottom, which is regulated by a shutting bar for adjusting the amount of fertilizer to be sown. There are blade-type stirrers between each disc, which push the fertilizer towards the disc, and which ensure a regular flow of fertilizer from the machine. Although this type is not considered so good for sowing superphosphates, or any fertilizer of a damp nature, it will give an even distribution of from $1\frac{1}{2}$ up to 15 cwt. per acre.

There is no better outfit for giving an even distribution of basic slag, ground lime, bone or any of the drier fertilizers. It is easy to clean and repair, as it takes only a few minutes to dismantle.

It is also easily transported through narrow gates by removing the shafts and fixing transport brackets.

Fig. 2.23 is a *Tullos-Wilmo machine.* This type of machine

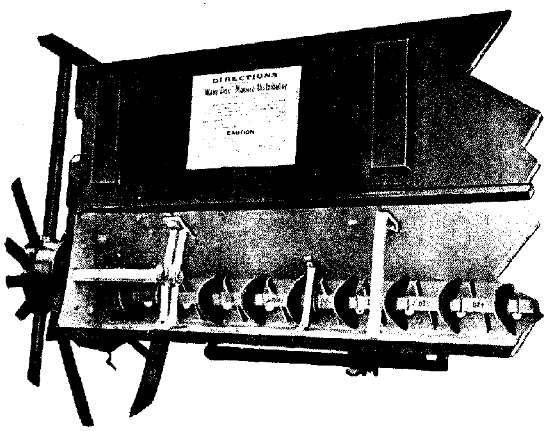


Fig. 2.22.—" Wave Disc " manure distributor
(Barclay, Ross & Hutchison, Ltd., Aberdeen)

has been used very extensively in Denmark for a number of years. The distribution of various kinds of fertilizer is as accurate as in any machine which has been made. It is quite simple in design

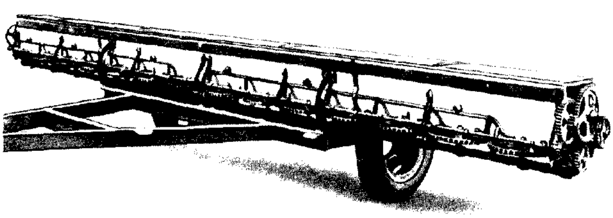


Fig. 2.23.—" Tullos-Wilmo " fertilizer distributor
(Tullos, Ltd., Aberdeen)

and consists of plates revolving at the bottom of the box carrying the fertilizer. Each plate comes in contact with a three-pronged spreading device. As the shaft turns, the fertilizer is swept from the revolving plates. If the spikes are properly set, they give a very even and complete distribution. A gear on the drive shaft contacts the gear ring on the underside of the plates, and the distributing shaft is contacted by gears from the left side of the machine. The gear drives at the end are well protected against

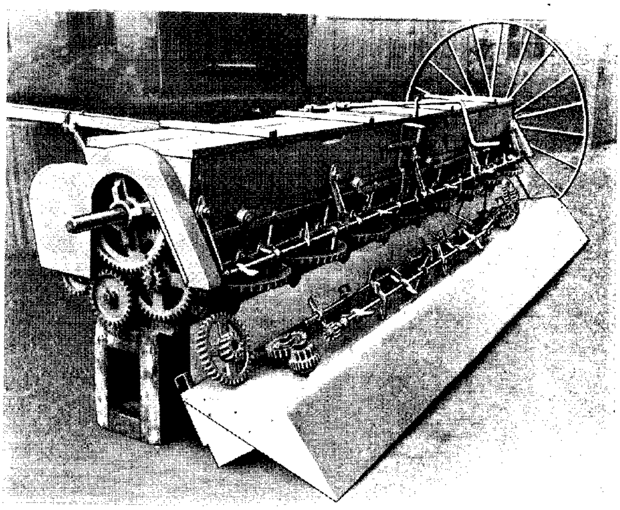


Fig. 2.24.—Dual-purpose fertilizer distributor, showing alternative dusting mechanism (*Tullos, Ltd.*)

any stones or foreign matter coming in contact with them. This machine is also made with extra changing gears, which are most useful when additional high-speed distribution is required. The makers claim that, by using interchangeable gears, the machine will sow from 50 lb. up to 3000 lb. per acre.

The dual-purpose Tullos-Wilmo fertilizer distributor and duster (fig. 2.24) likewise has a wooden fertilizer box. As a duster it will distribute efficiently flea-beetle dust, wireworm dust and "Agroxone". When the conversion is being made from fertilizer distribution to dusting, the jack supplied with the machine is used to raise one road wheel at a time and remove it, so that

the alternative spreader intermediate wheel and the gear bracket (complete with gears) can be fitted and a duster finger-bar with special fingers incorporated. The machine is then reassembled for immediate work.

Mechanical Muck-loaders.

One of the hardest and most disagreeable jobs a farm labourer has to do is the handling of muck. A great deal of thought has been given during the war years to the designing of a *muck loader*. There is more than one type but, at the time of writing, the most

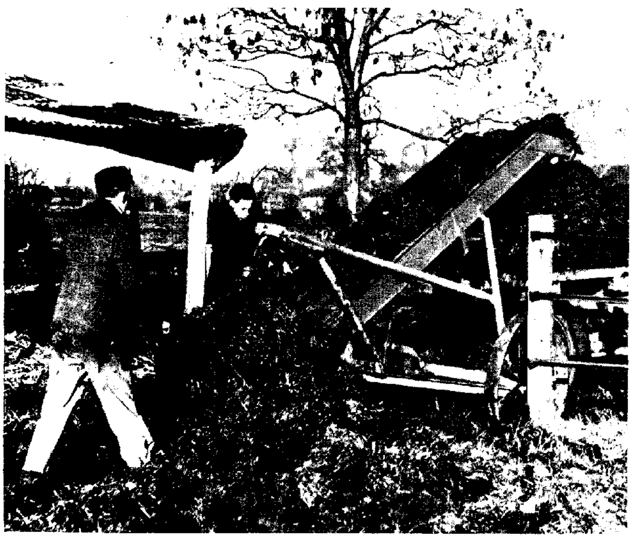


Fig. 2.25.—Wild-Thwaites muck-loader
(*M. B. Wild & Co., Ltd., London*)

successful is that designed by Mr. L. B. Thwaites in 1944 (fig. 2.25). It has a steel frame, on which are mounted a petrol-engine-driven elevator and winch. On the winch drum is a rope with a loading fork attached. This fork can be pulled out to cover a wide area and it collects and deposits the muck in a hopper at the foot of the elevator. Two men are required to operate the loader. One manipulates the fork by placing it behind the heaps

of muck; the other controls the winch clutch, so drawing the fork towards the machine, or freeing the barrel to permit the fork being pulled away from the machine.

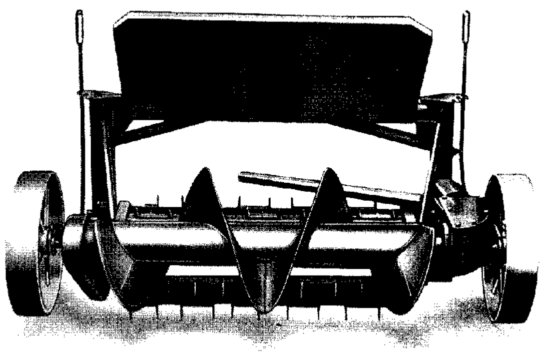


Fig. 2.26.—Wild-Thwaites muck-spreader

Farmyard Manure Spreaders.

Another very useful machine is the muck spreader. This consists of a drum with a right-and-left-hand spreading screw, which

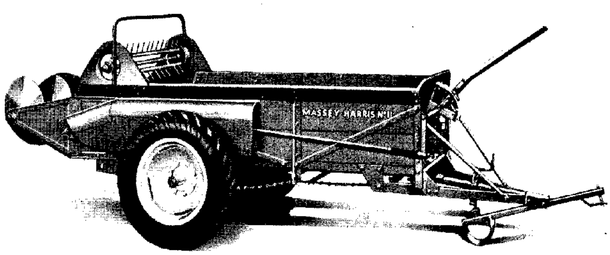


Fig. 2.27.—Farmyard manure spreader
(*Massey-Harris*)

gives a fairly wide and even distribution of farm manure; it has also a shredding drum of the squirrel-cage type with steel discs on the shaft which supports the collecting bars and shredding fingers. The drive is taken from the tractor power take-off, thence through a shaft to the gearbox, through which gearbox the two operating drums are driven. Where muck is put out in heaps in the fields, the use of this manure spreader represents a big gain in labour-saving (fig. 2.26).

Both the foregoing Wild-Thwaites machines are manufactured by M. B. Wild & Co., Ltd., London.

Another well-known manure spreader is manufactured by Massey-Harris, Ltd. (fig. 2.27). It has a long, low type of wagon frame with a conveyor in the bottom. This moves the manure slowly towards the end of the wagon, and it is broken up by a revolving spiked cylinder. Below this cylinder is a revolving drum which distributes the muck behind the machine. Although this type of machine works very satisfactorily it has not been so rapidly introduced into farming practice in Great Britain as would have been expected.

CHAPTER III

Harvesting Machinery

Every season the first crop-cutting machines to be used are *mowers* to cut grass to be dried, or for grass silage, or to make hay.

In many districts, where the land is not cultivated so intensively, farmers leave a fair proportion of their grass area for hay, apart from reserves for pasturing. There are different crops of

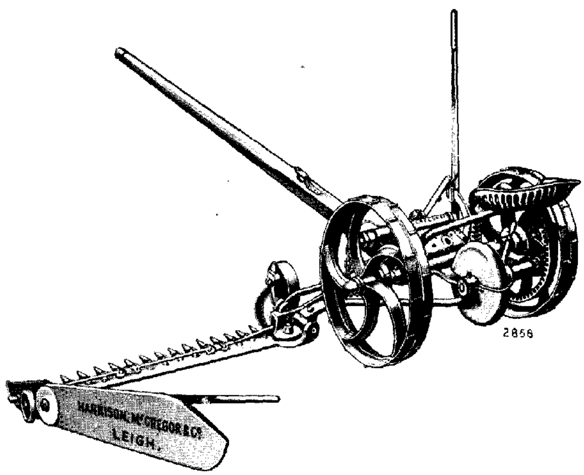


Fig. 3.1.—" Albion " mower made in the seventies

hay, such as clover hay where clover is sown for seeding, rotation grass and clover hay, timothy hay and meadow hay. In certain parts of England quite a lot of clover hay is grown, while in Ayrshire and Northern Ireland much of it is for seeding perennial and Italian rye-grass. Because of the scarcity of agricultural labour, farmers have been driven to adopt the most modern methods

for cutting grass and for hay-making, and that implies the use of the latest labour-saving machinery.

Before the early sixties, the cutting of the hay crop was all accomplished most laboriously by hand with hooks and sickles. Now we have not only mowers for cutting the grass, but swath-

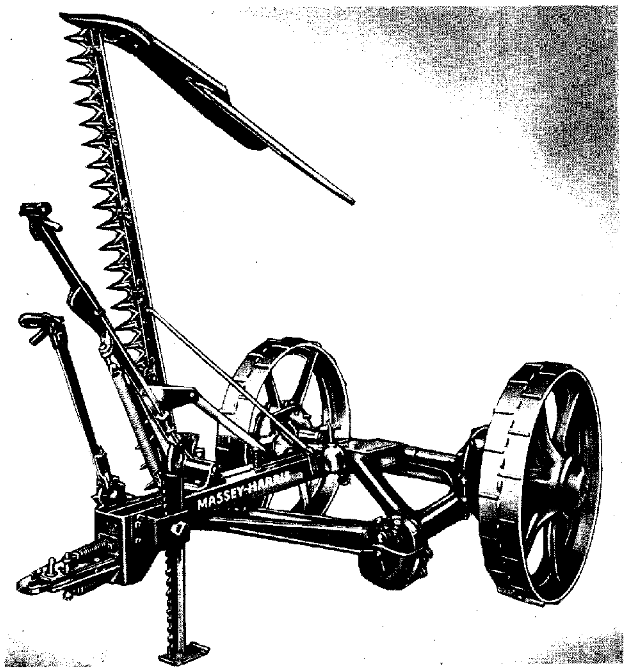


Fig. 3.2.—Tractor trailer mower
(*Massey-Harris*)

turners and hay-tedders for turning and spreading it, while other refinements include pick-up collecting and baling machines.

Little Change in Mowers.—The mower first came into considerable use about 1860, and, apart from minor improvements, has been little changed since that time. It would be wrong to say there have not been improvements, but the design and type of machine in use to-day bear quite a resemblance to those of seventy

years ago (fig. 3.1). As long ago as 1873, *Henry Harrison* and *Alexander McGregor* built mowers with both *right- and left-hand cut*, and these machines were made with *reaping attachments* which were specially useful also for the cutting of corn. Apart from the method of tilting the cutting-bar by means of a hinged pole-plate, and a higher travelling wheel, that machine is practically of

Fig. 3.3.—International trailer mower

the same design to-day as it was then. I have seen fifty-year-old machines cutting hay—surely a great tribute to the technique of the manufacturer of those days. Mowers have been improved in details, as, for instance, by the provision of oil-bath gearcases, forced-feed lubrication by means of a small rotary pump, and so on.

The work of the mower is not only in the hayfield—it is a very valuable machine for cutting laid and tangled grain crops, and for trimming down pastures on which excess roughage has

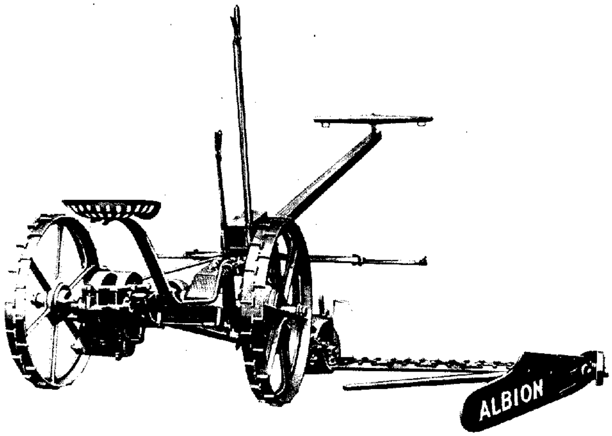


Fig. 3.4.—Albion 16R mower

Fig. 3.5.—Tractor-mounted mower
(*Tullos Ltd., Aberdeen*)

sprung up. From the user's point of view it is vitally important to see that the knives, or blades, are always kept very sharp, and that the fingers through which they pass are in good order and in correct alignment. The main reason for mowers being stiff to pull is misalignment of the cutting-bar with the frame of the machine, causing not only the additional draught, but also poorer results in the cutting.

Reaper Superseded the Scythe

The first *reaping machine* to be successfully used was made by the *Reverend Patrick Bell* of Carmyllie, Forfarshire, in 1827. It was for the use of his brother at Inchmichael Farm, and gradually found its way into the neighbouring counties of Perth and Fife.

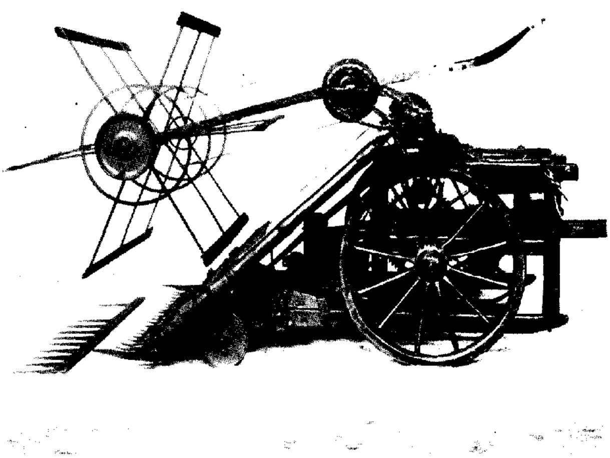


Fig. 3.6.—Reaping machine made in 1827 by Rev. Patrick Bell, Carmyllie, Forfarshire

Several other machines were invented in various parts of the country about the same time, but the condition of the agriculture of that day in Scotland was somewhat backward, and these machines were not used to any great extent. It was not until the great International

Exhibition of 1851, when McCormick from the United States displayed his machine, that enthusiasm was aroused, and farmers all over the country began to purchase and use these machines. It will be seen from fig. 3.6 that Bell's outfit was pushed by the horses instead of being pulled.

About the same time as they made their mowers the firm of Harrison, McGregor produced three types of reapers—*the manual reaper*, the *back-delivery reaper*, and the *side-delivery reaper*. The

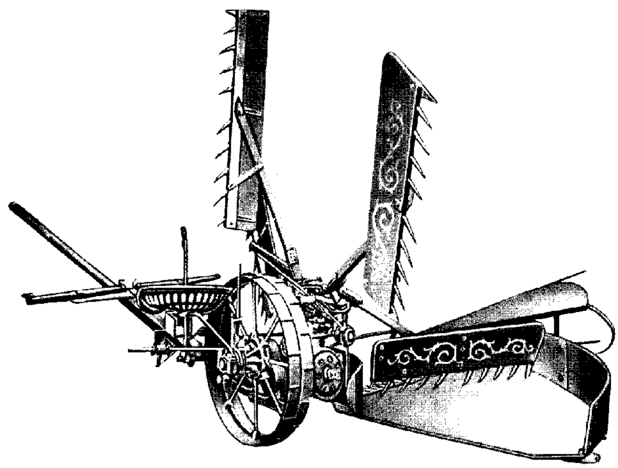


Fig. 3.7.—Albion side-delivery reaper

manual reaper was so called because one of the operators had to form and deliver the sheaf. Large numbers of them were in use in the early eighties, but on the introduction of the self-binder, they rapidly disappeared. The back-delivery reaper dispensed with one of the operators, as it gathered the sheaf and delivered it. A great many of these machines were used in Scotland, but they shared the same fate as the manual reaper on the introduction of the binder.

The *side-delivery reaper* (fig. 3.7), as its name implies, differed from both the manual reaper and the back-delivery reaper. It threw the sheaves completely clear so that the horses and reaper could pass up the track on the next round, whereas the sheaves of grain from the two former machines had to be moved before the reaper

could operate on the next round. This type of machine is still manufactured in large numbers, mainly on the continent of Europe. Many of them are used for cutting such crops as vetches, peas and clover.

Binders—Agricultural Engineers' Greatest Achievement

The binder was first introduced in the early 'fifties, but it was not until some thirty years later that real success was attained. Wire was tried in place of twine in the early 'seventies, but it was found to be unsatisfactory. The Appleby knotter for twine binding was introduced in 1879, and has been little changed to this day. There is no doubt that the introduction of the *self-binder* is the greatest achievement that has been yet accomplished

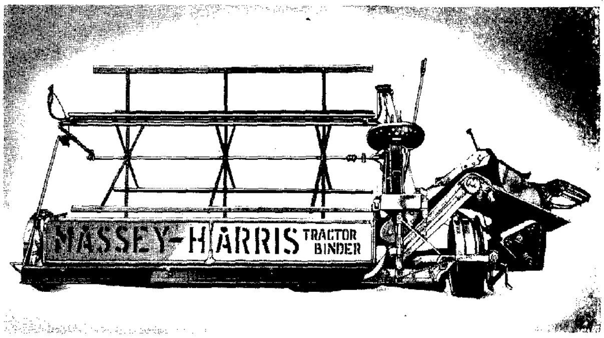


Fig. 3.8. -Tractor binder

by the agricultural engineer. No other agricultural machine, except perhaps the thresher, has saved so much manual labour. It can be fitted with sheaf carriers so that two or three sheaves can be deposited in groups convenient for handling.

Most binders come from America. In 1894 six English firms were making binders, and it is much to the credit of Harrison, McGregor that they have stayed the course so well, being the only English firm making binders on a large scale to-day. Other firms have all gone out of this line of business.

After the advent of the tractor, manufacturers had to build

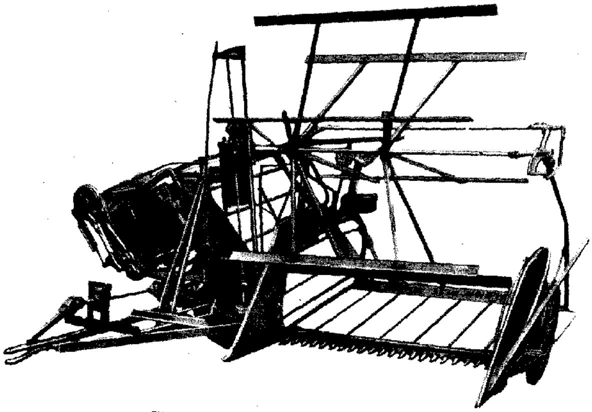


Fig. 3.9.—Albion SA power-driven binder

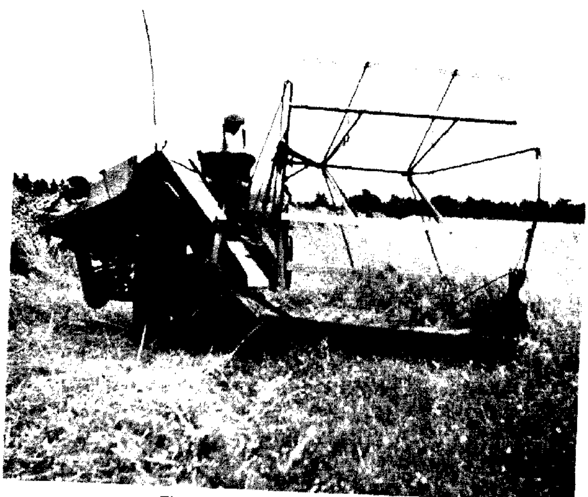


Fig. 3.10.—International tractor binder

tractor-binders—stronger and heavier machines to withstand the framework stresses accompanying the considerably increased speed compared with the horse-drawn machines. It is considered, with an average crop of oats or barley, that a 6-ft. or 7-ft. cut tractor-binder can cut 20 acres per day, against less than half that area using a horse-binder. The area cut in one day by an expert hand with the scythe is about two acres, if he does no gathering and binding.

Horse Rakes

It is generally agreed that the sooner the farmer stores his hay crop after cutting the better, as undoubtedly it is of greater feeding value if it is put into store after the briefest possible curing period. There are various aids for doing this. If the weather is very good a *horse rake* can be used for dragging it into windrows

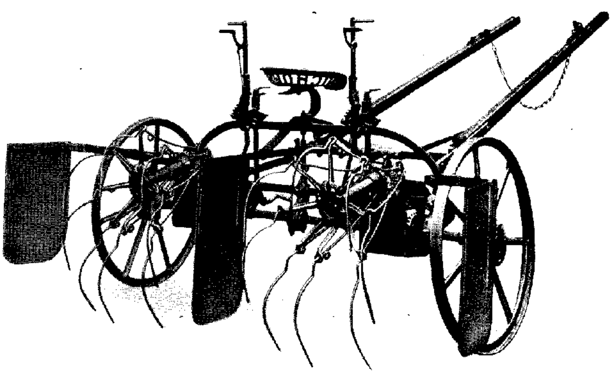


Fig. 3.11.—Swath turner
(*W. N. Nicholson & Sons, Ltd., Newark*)

or instead a *side-delivery rake* can be used. One of the most useful machines is the *combined swath-turner, tedder and side-delivery rake.* It is surprising, in suitable weather, how quickly hay can be put into small stacks by using this versatile contrivance to subject the fodder to the process of continual aeration and exposure to the sun.

All-purpose Rakes.—The introduction of the side-delivery

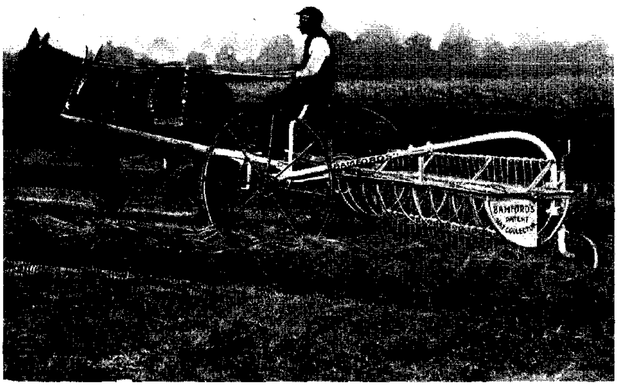


Fig. 3.12.—Side-delivery rake made about 1908
(*Bamfords, Uttoxeter*)

rake in this country came in the first decade of the present century. *Bamfords* of Uttoxeter were pioneers, and their first production was a rear-action model with three rake-bars driven by bevel gearing from the road-wheel axle, on much the same principle as

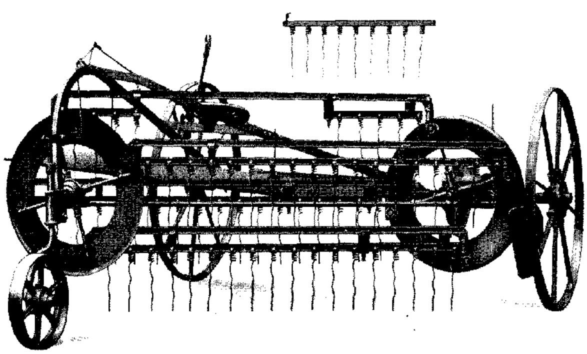


Fig. 3.13.—Rear-action side-delivery rake
(*Bamfords*)

the present-day machine. This outfit was welcomed by farmers as a great labour-saver; later, a *reversible two-speed gearing* was fitted so that the machine could be used for the purposes of *side-raking and tedding*, a slow speed for side-raking and the quicker reverse speed for tedding. In 1915 a new model was introduced with a " gap frame " and spiral-spring tines, thus making it adaptable for swath-turning in addition to side-raking and tedding. Later, improvements were added which included an *unchokeable furrow wheel* preventing the winding of the crop round the bearings of the wheel, oil-bath gearcase, and adjustable sliding tine-bars to suit varying widths of swath.

Horse and Tractor Hay Sweeps

Owing to the unsettled weather conditions so often experienced in this country the rapid handling of hay, as already noted, is a matter of great importance. The hay sweep and, particularly, the tractor hay sweep are highly serviceable in the quick handling of

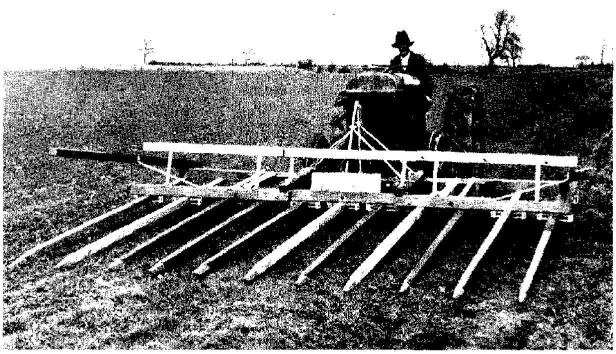


Fig. 3.14.—Tractor hay sweep
(T. M. Jarmain, Ltd., Oxford)

hay. It is many years since the *horse hay sweep* came into use, but within the last ten years *tractor sweeps* have become very popular. They may be fitted in a few minutes to the front of almost any make of tractor. Many sweeps are made 12 and 14 ft. wide. Fig. 3.14 shows one fitted with spring devices for the tines, or teeth,

which certainly minimize breakage. The sweep can be operated from the driver's seat. In view of its excessive width it is made to fold so that it can be easily transported along narrow roads and through gateways.

Hay Loaders

The *hay loader* (fig. 3.15) has also been evolved to lessen labour and to secure the hay more speedily. It can be very quickly and easily hitched behind a cart or lorry, and will elevate the hay on to the vehicle. The rake-bar type is driven by a crank. Some loaders have a tapered bed so that, while ensuring a wide pick-up

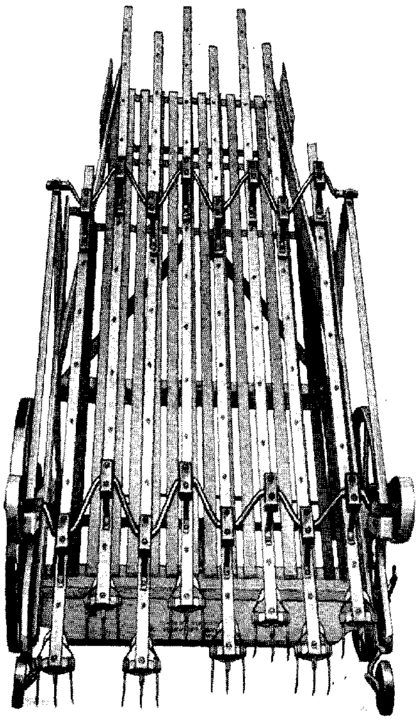


Fig. 3.15.—Hay loader (*Bamfords*)

at the bottom of the chute, the top, or delivery end, is narrowed down so that the crop can be delivered in the centre of the load. This prevents the hay from falling off the wagon. The loader illustrated is fitted with four-throw balanced cranks, which ensure a steady and even flow of the crop on to the wagon. This type of loader has proved to be highly effective.

Stacking Elevator

Stacking elevators may be used for the conveying of hay, corn or straw, and are favoured by farmers in this country, as well as on the Continent. They are made of various heights, being from 20 ft. up to over 30 ft. long, and save a great deal of hard labour when elevating hay to the top of a stack. Most of these outfits can be driven by a $1\frac{1}{2}$-h.p. engine, which can be fitted inside the elevator frame, and can be covered over by steel sheeting, pre-

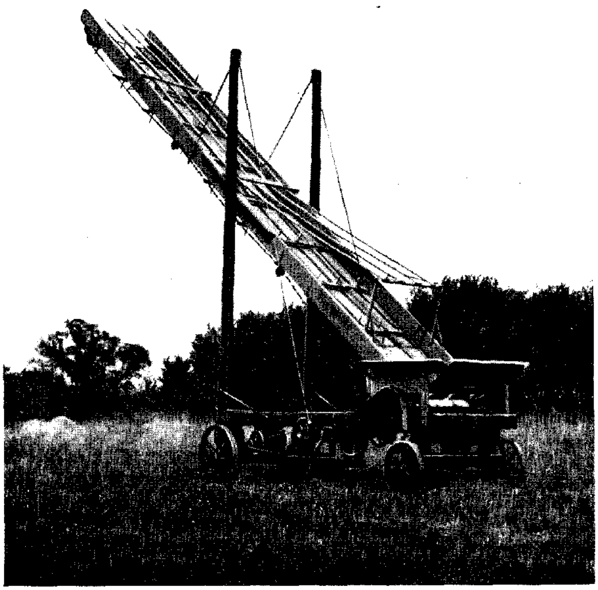


Fig. 3.16.—Stacking elevator
(Carter Brothers (Billingshurst), Ltd., Billingshurst)

venting the engine from coming in contact with falling straw or hay. Angle-gear attachments can be fitted for working the elevator, in conjunction with threshing machines, to deliver the straw at any angle on either side of the thresher, or straight ahead. To operate this attachment it is only necessary to place the elevator at the desired angle to the thresher, loosen the set screw, swing it into required position, then slide the pulley in or out of the shaft to bring it into line with the pulley on the thresher. It can be rapidly dismantled for transport.

Hay Balers

By the advent of a *one-man baler* (fig. 3.17), hay or straw can be picked up from the swath and baled in one operation. Although there are great advantages in baling from the field it must always be kept in mind that it should not be baled too tightly, as it contains a certain percentage of moisture. When too tightly baled, it is liable to be damaged by heating. It is generally recognized that hay with a green tint has a much higher feeding value than if it is left too long to bleach in the swath. With the latest one-man, automatic, pick-up balers it is possible to pick up and bale as much as six tons per hour, depending largely on the condition of the crop. Bales weigh up to approximately 50 to 60 lb. This type of baler has a floating auger and a packer finger. A knife is mounted on the plunger, which slices each charge on the packing stop. An adjustment is provided for the packing finger to regulate the placing of material within the bale chamber, so that it provides an even bale, regardless of the type of material being compressed.

" Combines " are not a Modern Idea

The " Combine " harvester, or harvester-thresher, does the work of both the reaper and the thresher. Contrary to the opinion of many people the Combine harvester is not a new invention. The *first combine type of machine* was worked a hundred years ago. It was only natural that the thoughts of engineers should have turned towards the collecting and threshing of a cereal crop in one operation, and especially in those countries where the only part of the crop that was of any value whatever was the actual grain. The first attempt to harvest the grain only, leaving all the

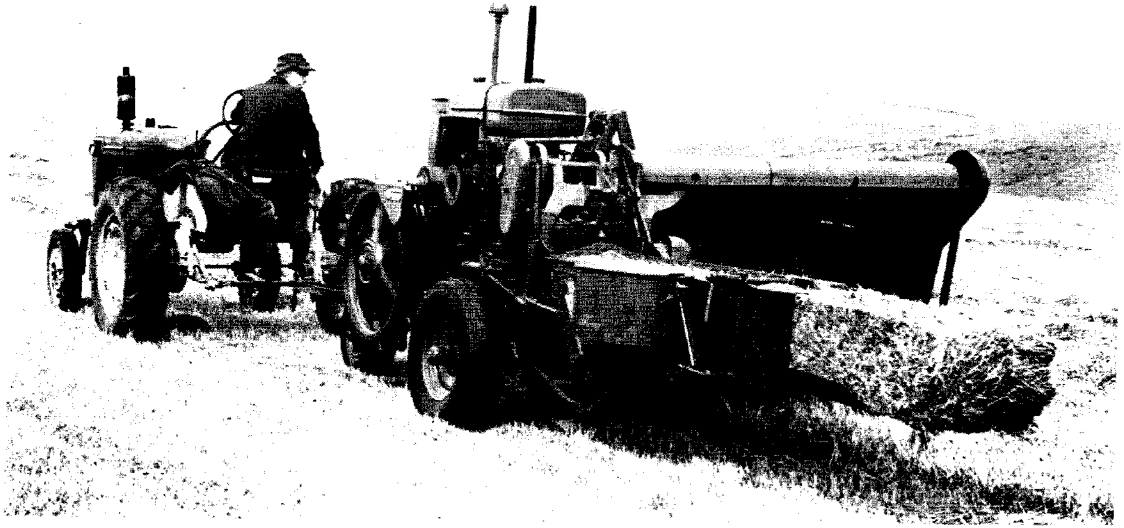


Fig. 3.17.—One-man automatic pick-up baler (*International*)

rest of the crop—straw, chaff, cavings, &c.—on the field, was made in Australia, and it appears probable that the first machine was operating in 1845. This, of course, was a machine drawn by horses, and it did not cut but stripped the corn from the ear. The grain so stripped, together with some amount of chaff, was conveyed by worm into the machine, while the straw remained as it had grown in the field. After some time a winnower was added to the stripper, and the resultant partly dressed grain was collected and redressed on the farm. It will be apparent that this type of machine was particularly useful for wheat and was only suited for a standing crop of comparatively equal height. Nevertheless the stripper was very extensively used in Australia, and in the early years of the present century was being exported in large numbers to the Argentine, Chile, North Africa, &c.

On the American side of the Pacific Ocean, in California, Combines were also being developed. These machines, which had a large capacity with a wide cut, were pulled by steam traction engines, and were probably suited for large fields only and farming on an extensive scale. The advent of the internal-combustion engine made possible the modern harvester-thresher. Animal draught meant that the travelling speed of a machine varied considerably due to hills, soft ground, &c. Consequently any dressing that was attempted was good or bad according to the speed at which the machine was pulled. When it became possible to put an engine on to the Combine, so that a constant threshing speed could be maintained irrespective of the speed at which the machine was being pulled along the ground, then consistently good work became possible. The development of the modern harvester-thresher took place in the United States, in the Argentine, and in Canada, and for this reason the earlier machines had very wide cutting-bars. Sixteen feet of a cut was the usual and there were even larger sizes manufactured. In this connexion it should be remembered that in all the three countries mentioned, yield per acre is generally much lower than in Great Britain, or even than in Europe, and as soon as machines began to be used on this side of the Atlantic it became necessary to reduce the width of the intake. A machine that would successfully thresh and dress the grain from a 16-ft. cut in Canada or the States, would have difficulty in dealing with the grain from a cut of 10 or 12 ft. on this side. It meant, of course, the designing of a special machine with a narrower cut, and in all probability such a machine was also of

considerable value in those parts of Canada and the States which were more highly farmed than the great western areas.

Costly but Extensively Used.—Combines were first introduced into this country in 1928, although they had been manufactured in England for export at an earlier date, when there was a demonstration of harvester-threshers and grain driers in Wiltshire. Considering the novelty of the machine, the prejudice which had to be overcome on the part of both the farmer and the grain merchant, and the large sum of money which had to be expended for a machine to use at the most during four to six weeks of the year, their numbers increased fairly rapidly, till, in 1934, there were estimated to be about fifty at work. In 1948 there were 5230 in Great Britain.

Three Types in Use.—At the moment there are three types of machines being used:

(1) the *self-contained and self-propelled machine* (fig. 3.18);
(2) the machine which has its own engine to drive it, but is *hauled by a tractor*;
(3) the machine which is hauled by a tractor and *driven from the power take-off* of the tractor.

These short descriptions explain themselves, and it is fairly obvious that the self-contained, self-propelled machine will be the most expensive, but probably the most efficient. The width of cut of machines used in this country varies from 5 to 12 ft. Generally speaking, the threshing unit is central, just behind the cutting-bar, although this is not invariably the case. The cutter-bar, which, of course, has raising and lowering gear, is a development of the bar to be found on any binder or mower. As the threshing unit is usually considerably narrower than the width of cut it is necessary to convey all the grain to the centre of the cutter-bar. This is done on some machines with a canvas. On others it is done by means of augers, and it would appear as if the auger is becoming the generally used method. From the centre portion of the cutter-bar a canvas, similar to a binder canvas, generally raises the cut crop to the threshing drum. This canvas may or may not have a beater fitted above it.

The threshing drum may be any one of three types:

(*a*) the peg drum and concave, such as is usually fitted to an American threshing machine;

(*b*) the beater- or rasp-type drum and concave, such as is usually fitted to the British threshing machine; or

(*c*) the flail type which is a simplification of the beater or rasp type.

On machines used in this country it will probably be found that the majority have a drum and concave of the beater or rasp type. When the threshed straw leaves the concave, there is usually to

Fig. 3.18.—Twelve-foot self-propelled " combine " harvester (*Massey-Harris*)

be found a beater similar to those which are a feature of American-type threshers, but which are not found in the British design. The function of this beater is to keep the drum clear, and to throw down everything that comes out of the drum on to the top of a grating or grid. From this grating or grid the threshed straw is delivered to the shakers. Although these are not identical in design with the average British thresher, they usually work on exactly the same principle and are actuated by two crankshafts.

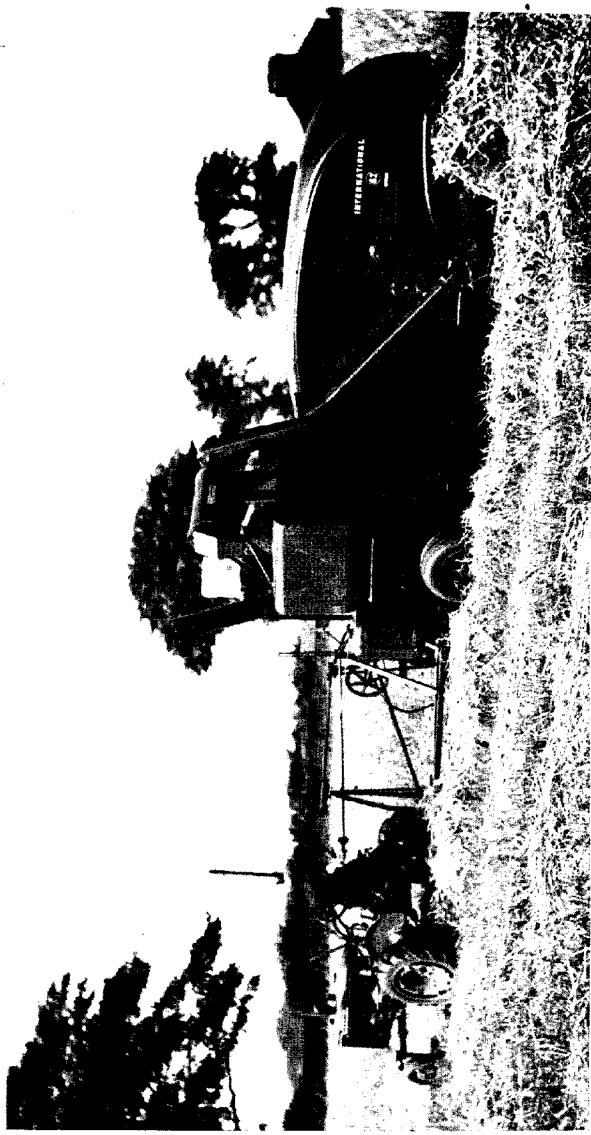


Fig. 3.19.—Six-foot power-driven Combine harvester (*International Harvester Co., Ltd.*)

It is interesting to note that while threshing machines of American manufacture usually have straw racks and not straw shakers, the majority of the harvester-threshers use straw shakers. The straw, having been shaken clean by the shakers, falls on to the ground. The rest of the material passes to a series of dressing riddles, where, by means of a blast from a powerful fan, chaff and cavings are blown away and fall to the ground with the straw. The same riddles carry forward what usually would come out of a British thresher on the pen riddle—that is, unthreshed ears, &c. These are wormed across the machine into an elevator, which delivers them to the threshing drum to be dealt with again. The dressed grain is elevated and many of the machines have fitted to them a *weed screen*. This screen is not the adjustable rotary screen so familiar to the British user, but is a perforated cylinder along which the grain passes, the holes being small enough to retain the grain and allow the weed seeds to fall through. A few harvester-threshers are fitted with adjustable rotary screens, but the majority have the weed screen only.

Handling of Grain.—According to the make of the machine, the grain may be handled in a variety of ways. It may, for instance, be bulk-handled. This is to say, the grain elevator may deliver the corn into a tank or grain bin carried on the Combine, and the machine may be stopped periodically to empty this bin. The elevator delivery may be fitted with bagging apparatus, and the grain may be bagged off by a man riding on the machine. The elevator may be of sufficient height to allow it to deliver into a box wagon, which is drawn alongside and keeps pace with the Combine.

It should be noted that a Combine works under ideal conditions so far as threshing and dressing are concerned. Assuming that the crop is of such a quality that the threshing unit is equal to dealing with all that the cutting-bar can cut, the machine is self-regulating. There can be no over-feeding; there can be no irregular feeding; so long as the machine moves forward, a perfectly regular stream or ribbon of straw passes to the threshing drum, an even quantity of threshed straw passes to the shakers and a steady flow of grain, chaff, &c., goes to the dressing apparatus.

Early Fears were Unfounded.—It is interesting to look back to the early days of the harvester-thresher in this country, and to note how far removed from reality were some of the fears originally expressed. For example, it was expected that barley would be the last grain to be attempted with the Combine. As a

matter of fact there is now possibly a greater quantity of barley " combined " than of any other grain! It may be, of course, that this is due to the excellent driers and cleaners which are to be found in some large barley-growing areas. It may also be because of all straw, barley straw is of the least value to the farmer. Whether or not these two factors have any important bearing, it is accepted that the harvester-thresher has been a great success in handling barley.

Another way in which the self-propelled machine has distinguished itself, has been with laid crops. In quite a number of instances in Scotland, where oat crops were so badly laid that nothing could have saved them except hand-cutting with a scythe, the self-propelled Combine went into the field and collected and threshed at least 90 per cent of the crop.

There are occasions when it may be necessary to cut a crop and let it lie a while before it can be threshed. One of the reasons for this is a weedy bottom, or a considerable growth of undersown seeds. It should be noted that the moisture content of a grain crop may be increased by as much as 2 per cent between the actual cutting and the delivery of the grain into the bag, this increase being moisture, collected by the grain in its passage through the Combine from the green weeds, &c., which are cut with the straw. Such a crop may be windrowed, i.e. it is cut by a machine, made into windrows, and left to dry for 2–3 days. After being sufficiently dried out the windrow can be collected by the Combine and threshed. But the windrow plan means taking considerable weather risks in our climate.

Handling the Straw.—Threshed straw is delivered in an even stream by the Combine as it moves across the field and possibly, in the case of barley straw, it may be left where it lies, disked over, and then ploughed in. With wheat and oat straw, some method of collecting is necessary. It can be swept up in the same manner as a hay crop; it can be picked up by a pick-up ram baler and baled. There are two types of balers. One uses wire and makes a tight compact bale which can be handled for sale; the other uses string, which makes a bale suitable for handling the straw about the farm.

Grass Pick-up Appliances

Due to the circumstance that dried grass is the product of herbage at a short stage, and amounting to relatively moderate bulk over a wide area of land, engineers found themselves wrestling with another ticklish problem in addition to the construction of grass driers. They had to produce machines to cut very short grass—which is a different proposition from mowing hay—and had to incorporate in the resultant grass cutter the extensions needed to collect, or elevate and collect, the cut material into a detachable trailer.

Wilder's of Reading were pioneers in making the first grass pick-up machine. The " Cutlift " cuts and delivers the crop into a trailer in one operation, and can be used for the cutting of short or long grass or silage crops. It will deal with growths up to six feet high. It is close-coupled, and the knife and the elevator are driven by the power take-off of the tractor. It can be adapted to any type of tractor (fig. 3.20).

The cutter-bar is quite independent of the elevator and it can be raised or tilted like an ordinary mower. This bar is supported in the centre and joined to the main rear axle by a hinged channel bar, which keeps the cutter-bar and the elevator at the correct distance apart, as it prevents the cutter-bar bending back. Twin fingers are fitted to the cutter-bar for the cutting of very short grass close to the ground, but ordinary fingers are recommended if the crop is higher than 8 or 9 in., and also when the pasture is matted. The rakes can be set to work over, in front of, or behind the cutting-bar, depending on the type of crop being cut. A wind shield is provided to prevent the crop from hanging to rakes in a following high wind. Any tractor-trailer can be hinged closely to the Cutlift. All that is necessary is for the front boards to be cut down so that they pass under the delivery hopper. To ensure continuous operation of the Cutlift it is necessary to have two trailers; while one is being towed along and is filling the other is being hauled to discharge at the drier.

A later type of pick-up, which performs satisfactorily, is the " Hosier " (fig. 3.21). It is of simple construction and its moderate cost appeals to those whose dried-grass requirements are not extensive. One method of using this make is to hitch it directly behind a

hay mower *(fitted with double finger-bar)* so that *it* " scoops up " the swath of grass cut during the previous round. The " endless-belt " principle is again employed here to elevate the cut herbage from the swath. The " belt " trails slightly on the ground at the front, its corrugated transverse bars getting under the grass and pushing it up the elevator chute in a wonderfully effective manner.

Fig. 3·20.—" Cutlift " combine *(John Wilder, Ltd., Reading)*

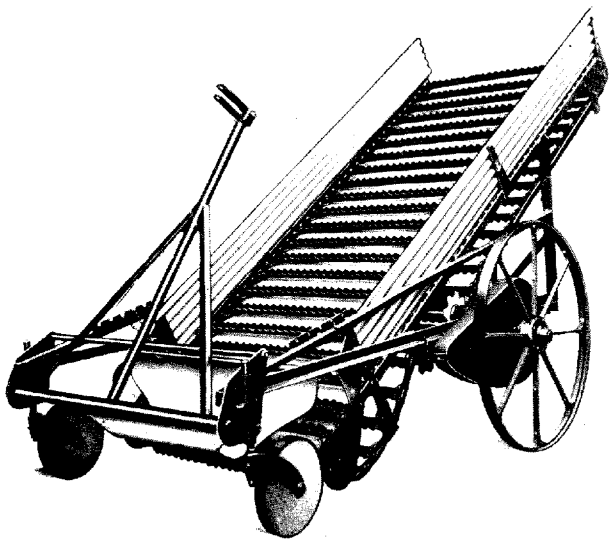


Fig. 3.21.—" Hosier " crop-loader
(S. M. Wilmot & Co., Ltd., Bristol)

Potato-handling Equipment

Elevator-type Potato Diggers.

In recent years quite a number of elevator-type potato diggers have been introduced in Scotland and later in England. One of the pioneers in the introduction of these was Mr. Wedderspoon, Castleton, Eassie, Angus. Being a large-scale potato grower he was instrumental in introducing and demonstrating a number of these at his farms.

There are certainly considerable advantages in an elevator-type digger (fig. 3.23); by lifting potatoes and allowing them to fall down in rows they are more easily collected. Although they will dig and put down the potatoes almost completely clear of soil, there is a certain disadvantage with this digger compared with the spinner type. Where there is heavy soil and damp conditions the earth is inclined to come over the elevator in lumps. The tubers

are not shaken clear and left as they would be when the soil is medium or light. There are two schools of opinion about this type

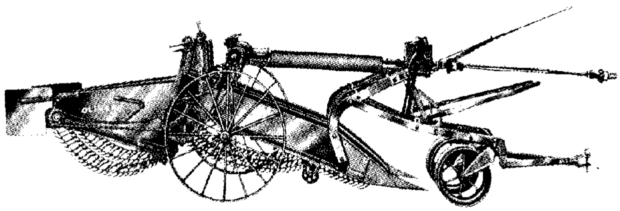


Fig. 3.22.—" Oliver " two-row power-lift potato digger
(John Wallace & Sons, Ltd., Glasgow)

of digger: one is that it should be equipped with three-speed transmission, and the other, which is predominant, favours the so-called single-speed elevator.

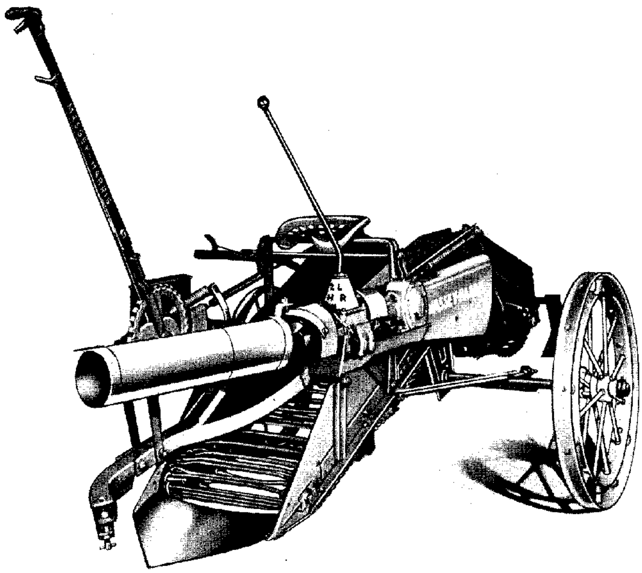


Fig. 3.23.—Elevator potato digger
(Massey-Harris)

Spinner-type Potato Diggers.

The spinner-type of potato digger is illustrated in fig. 3.24. The important working parts of this machine are the loosening share, the main spinner, the auxiliary spinner, and the drive for the spinners through a chain and bevel-gear from the main axle. The loosening share cuts through the soil under the tubers; the main spinner pushes the tubers out of the earth, and the auxiliary spinner receives the soil and potatoes. The tubers then glide along the tines and are separated from soil and haulms ready for lifting.

In some potato-growing districts the potato digger fitted with hanging tines is preferred. As will be seen from fig. 3.25 this type is of very simple design and is unequalled for lightness of draught.

Potato Harvesters.

For over a dozen years farmers have been toying hopefully with the idea of a *potato harvester*, and, during that time, engineers have been wrestling with the problems of design and construction, with enough success to encourage further endeavour. It would be a great advance to find on the market an adequate supply of machines that would lift this valuable crop from average soils; separate potatoes from stones; and at the same time place the tubers, preferably graded as to size, in sacks or hoppers. At present the scale upon which the potato crop is grown has been pushed up until it has passed the capacity of the supply of manual workers, including children, to gather it. The mechanization of that task is a step which simply has to come; moreover, it will cheapen to an important degree this robustly productive crop and enable it to provide more and more raw material for an ever-expanding range of manufactured products.

Potato Sorter.

The potato crop calls for much labour in cleaning and separating the ware from the seed. In 1885 *Henry Cooch* made his first machine for *grading and sorting potatoes* (fig. 3.26). It was awarded a silver medal at the Northamptonshire Show. In 1907 he added a conveyor to the sorter for hand-picking the potatoes. This had a canvas web, but in 1911 the web was altered, being made of wooden slats fitted on chains. Three years later the same maker introduced the steel-slatted web, which has been used ever since.

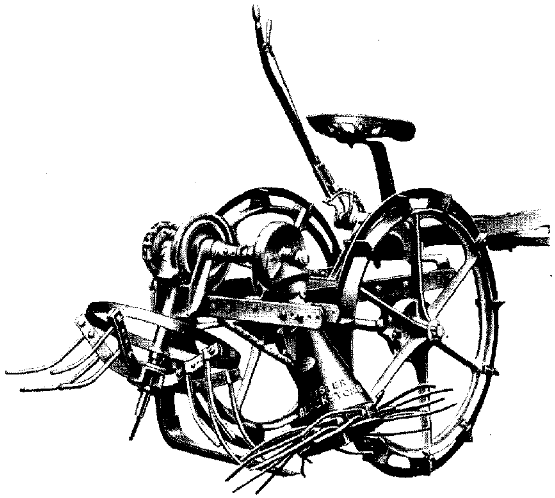


Fig. 3.24.—Spinner-type potato digger
(Lister-Blackstone)

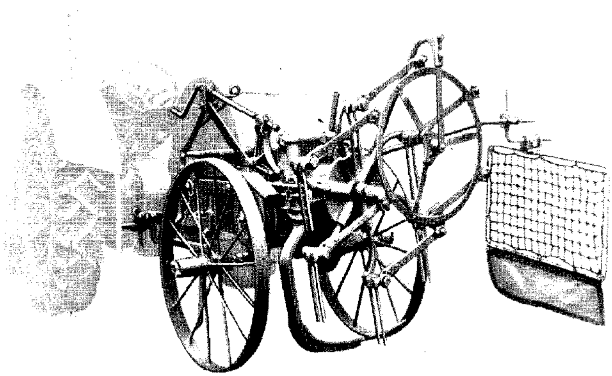


Fig. 3.25.—Potato digger with hanging tines
(Ransomes)

In 1937 a patent roller conveyor was awarded the silver medal at the Royal Show at Cardiff. There are several other makes of highly efficient types of sorters. Fig. 3.27 shows the latest type of Cooch roller machine being driven by a $1\frac{1}{2}$-h.p. engine.

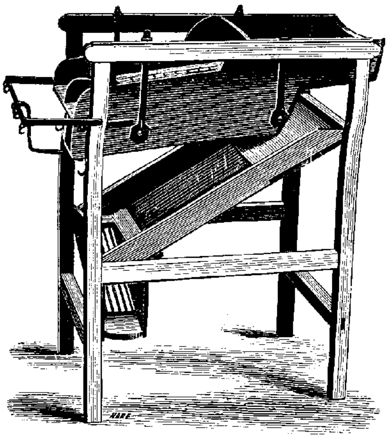


Fig. 3.26.—One of the earliest models of potato separator, made by Henry Cooch, Harlestone, Northampton, 1885

Many people believe that potato sorters are liable to bruise the tubers, and on this account a number of growers do not approve of them. Possibly makers would be well advised to consider the advisability of having the wire riddles covered with rubber, and I believe that many are considering this.

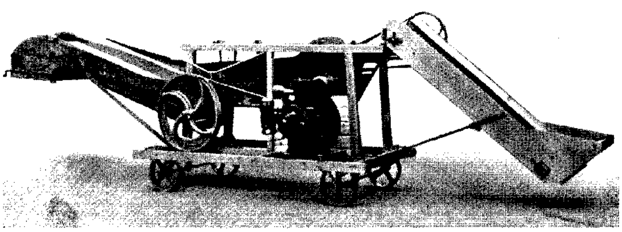


Fig. 3.27.—Engine-driven potato sorter with roller conveyor
(Cooch & Son, Northampton)

Beet-harvesting Machinery

At the time of writing *beet-harvesting machinery* must be regarded as still in the process of development. Only one machine —the Catchpole—is regularly on the British market, but there are over a dozen more or less experimental machines which may also be seen at work throughout Britain.

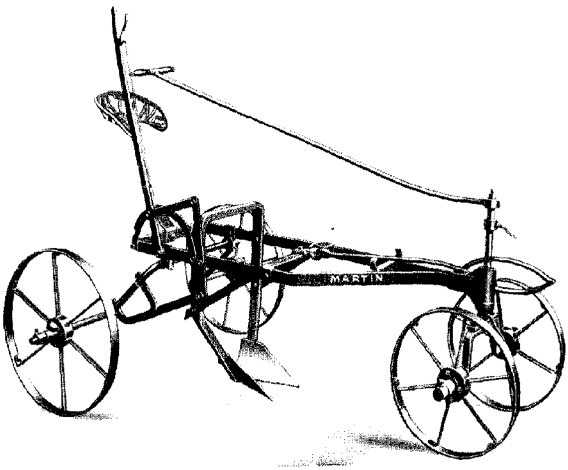


Fig. 3.28.—Sugar-beet lifter
(*Martin's Cultivator Co., Ltd., Stamford*)

Sugar beet is sent to the factories minus tops and soil. The tops require to be removed in such a way that no green matter remains attached to the root but, as the crop is of considerable value, it is essential not to remove too much of the top. Hitherto, the work of topping the beet has been done by hand, following the process of lifting the beet from the ground by means of a **sugar-beet plough** (see fig. 3.28). These ploughs are fitted with two prongs which slide on either side of the roots below ground level, and force them upwards out of the soil. They are then picked up by hand, and knocked together to remove any adhering soil. The tops, severed by a knife, are thrown in one row, while the roots

are pitched into another, or into a wagon. This operation proceeds at the rate of about $\frac{1}{4}$ acre a day for each person on the job.

Sugar-beet harvesters are intended to accomplish the whole task of lifting the crop, cleaning it, and removing the tops in one operation (fig. 3.29). Some are designed to discharge the beet into a trailer, while others are constructed to lay the roots in rows, or in heaps, on the ground. The tops, which are of great value for feeding cattle, and especially sheep, are laid in rows along the

("Farmer and Stockbreeder" photograph)

Fig. 3.29.—Sugar-beet harvester
(Catchpole Engineering Co., Ltd., Stanton)

ground. Certain machines are made to discharge the tops from several drills of beet into one row so that they may be picked up more easily.

With one exception all machines carry out the operation of *topping the beet* before it is removed from the ground. Several types of knife are in use, and the most successful comprise one (or more) rotating steel disc which acts like a horizontal ham-slicer. The height of the slicing knife is regulated by a *feeler device* which precedes the knife and rides on top of the beet. This device may take the form of a link-belt track, like a miniature crawler-tractor track; a wheel or disc running on top of the beet; a finger sliding over the beet; or a plate or disc with its convex side downwards.

After the passage of the knife the tops are usually flung to one side by a set of rotating flails or beaters, but they may be picked up by pronged wheels or otherwise carried to a conveyor which removes them to one side.

The beet are then forced out of the ground by either finger-type lifters or band-type lifters. The latter type must be used when the crop is carried on to a chain-elevator shaker similar to that on the *Hoover potato digger*, as the presence of soil is necessary to carry the roots on to the elevator. Other machines make use of a pair of rotating wheels with their axes on the skew, so that the rims on the wheels come together at the bottom and separate at the top and front. These wheels have the effect of squeezing the beet out of the ground.

Invariably the lifters are followed by some type of cleaning arrangement, which may take the form of a chain elevator, a drum, or a large-diameter wheel. Following the cleaning apparatus the beet may be discharged into a collecting hopper, which is itself discharged at intervals to produce piles of roots across the field, or puts them straight into a cart.

The one exception to the principles outlined above is the *American Scott-Urschl*, which lifts the beet before topping it. On this machine the tops of the beet are held between two bands, or chains, which close together on the tops and, as the machine advances, move to the rear at such a rate that the beet is not displaced horizontally, but is lifted bodily upwards. At the top of the chain's travel the beet encounters a slicer which detaches the roots and allows the tops, still gripped by the chain, to be carried to the rear. This machine has not been found successful in Britain as the beet tops are either too bushy early in the season or too brittle or soft at a later date.

The prices of beet harvesters vary from £350 to over £2000. The use of such a machine may be assumed to save approximately £5 per acre in addition to liberating labour for other work at a time when ploughing and the sowing of winter crops are in progress. It is to be hoped that there will soon be a considerable addition to the number of reliable and efficient beet harvesters on the British market.

Flax Pullers

Until 1940 there was not a great deal of flax grown in this country, and little thought or study was given to the manufacture of flax-pulling machines. Most of them were made in Belgium, but, when a large acreage was put down in this country during the war, quite a number of machines were made. The type illustrated

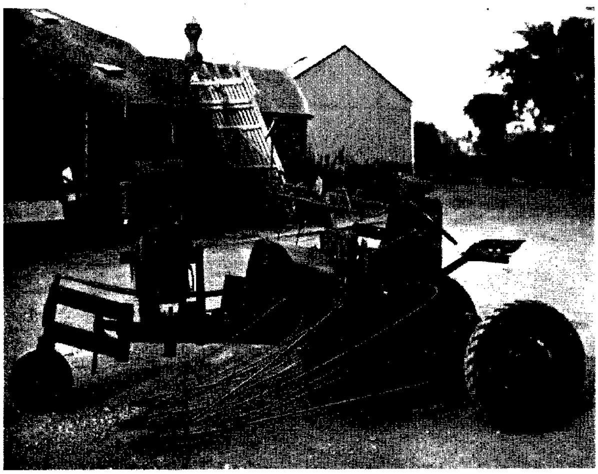


Fig. 3.30.—Flax puller (*Stanhay, Ltd., Ashford*)

is self-propelled. The crop is collected by suitable dividers and guided between the two sets of rubber-covered pulling drums. The flax is pulled by these drums and conveyed by rubber belts into the binder. The first machines were horse-drawn, later they were converted for tractor draught and now a large number are self-propelled.

CHAPTER IV

Food-Preparing Machinery

Threshing Machine Development and Features

Among food-preparing equipment threshing outfits of one type or another are of first importance, and the cream of the mechanical ingenuity of agricultural engineering of roughly three centuries is concentrated in the modern high-speed separating and finishing

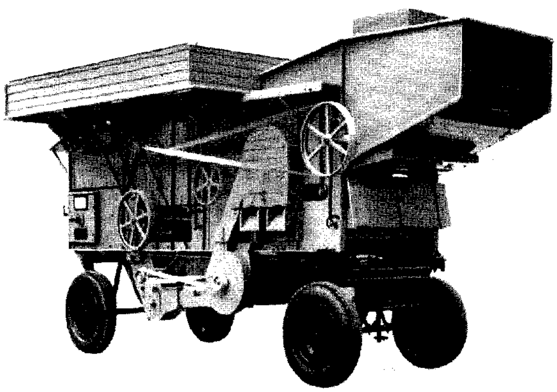


Fig. 4.1.—Portable thresher on pneumatic tyres; steel frame fitted with chaff bagger

(*Marshall Sons & Co., Ltd.*)

thresher. That machine is the embodiment of countless ideas for speeding-up and improving the operation of threshing, from the performance of the 2-bushels-per-hour flail to that of the 160-bushels-per-hour modern thresher. In its most familiar form the machine of our day is seen being towed about the country, or working in the stackyard doing giant deeds in converting the

crop into sacks of beautifully cleaned corn and huge stacks of straw. A specimen of these machines—monuments to the skill of our millwrights—is seen in fig. 4.1.

As most people are aware, it does a good deal more than the mere term "threshing machine" might suggest. It not only threshes the grain from the ear, but takes it out from the straw, delivers the short straw (or cavings) from the end of a riddle, blows away the chaff and the dust, polishes the grain, and finally divides the corn into three classes, according to its size. Before, however, entering into a detailed description of the modern thresher, it will be interesting to take a peep at the history of threshing.

There is, of course, the Biblical reference—not muzzling the ox which treads out the corn—but, so far as can be gathered, oxen or other animals were seldom used in our own country for threshing, as the unbroken straw had too high a value.

The Flail—Symbol of Drudgery.

Prior to the advent of any kind of threshing machine, the operation was carried out with a *flail* (see fig. 4.2). It consisted of two sticks jointed with a leather thong. The crop was spread on the floor of the barn and the threshermen beat it with flails, thus threshing out the corn from the ear. The straw was turned at intervals and the whole finally was loosened up. The straw then was at the top and was taken away leaving a mass of grain, chaff and little pieces of straw or dirt on the barn floor. This was then thrown up into a *draught of wind.* In this connexion it is interesting to note that, in some old steadings, there is still to be seen an apartment with two doors opposite each other. One of these doors may be for an obvious purpose and in everyday use, whilst the other manifestly has not been opened for generations. This pair of doors was arranged to catch the prevailing wind, and both were opened when the winnowing of the grain was to be done. There would be, under most circumstances, a sufficient draught to blow the chaff and little pieces of corn to one side, whilst the heavier grain fell vertically and thus became separated from the impurities. This style of winnowing did not remove the dirt and weed seeds but, in all probability, these were left either to be included in the meal made from the grain or to be taken out by the miller. The flail was used until quite modern times.

Fifty or sixty years ago the practice of *gleaning*, or gavelling, was quite common. That is to say the wives and children of farm

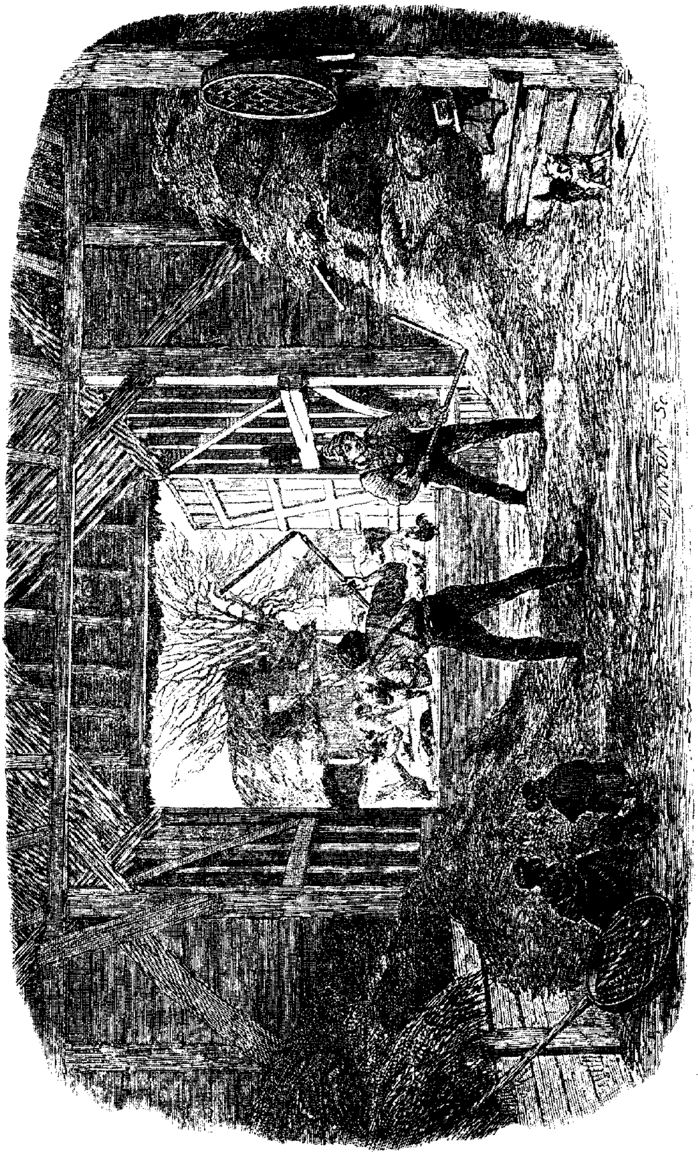


Fig. 42.—Threshing in 1846—use of flail ("Picture Post" Library)

servants were allowed to collect from the fields—after the harvest had been lifted—any straws they could find with grain still adhering. These gleanings were taken home and the good man of the house threshed them with a flail, the local miller ground them, and the result went some way towards providing flour or meal for the family.

Even at the present day, the flail is used by seed growers, and at experimental stations, to thresh out odd and special lots that are too small or, alternatively, too precious to risk the adulteration that might take place if the lot was put through a threshing machine.

Birth of Power-threshing Idea.

Threshing with a flail was monotonous, laborious and expensive in manpower. It is natural that, with the increase in mechanical knowledge, man should turn his attention to some machine for relieving him of this tedious work. The first feeble dawn of better times to come was in 1636 when a *thresher was patented* and is said to have been a machine with several flails operated by cranks. In 1711, a threshing machine was made in Germany, but nothing is known of the details of this innovation. In 1732, *Michael Menzies* made another using the principle of the flail, and driven by a water wheel. He took out a patent in 1734 and was advertising his thresher in 1735, giving particulars of costs, &c. A copy of what is probably his advertisement from the *Caledonian Mercury* of 26th August, 1735, reads as follows:

> " Whereas many have wrote from this country to their friends in Town about the prices of the Thrashing Machine, the following prices are here inserted for which the machines will be furnished, with the privilege of using them during the patent of Andrew Good, Wright in Edinburgh, whose home and shop are in College Wynd, viz.: to those who have water mills already one which will thrash as much as 4 men, £30 stirling, one which thrashes as much as 6 men, £45 . . . and so on, reckoning £7, 10*s*. for each man's labour which is about the expense of a servant for one year, whereas the patent is for 14 years."

A number of threshers were produced in the eighteenth century. Some of them were on the flail principle, but the machine which may be called the forerunner of the modern thresher was made by *Andrew Meikle*, of Tynington, in 1786. Meikle was working under the patronage of Sir Francis Kinloch, of Gilmerton, East Lothian. His thresher had a *revolving drum* provided with four beaters, these being fitted with hard oak pegs. The machine is

illustrated in fig. 4.3, and it will be seen that there was a small riddle also in the layout. It should be noted that this thresher of Meikle's was also the forerunner of the American machine. The U.S.A. thresher drums, from the very beginning, have been almost always fitted with pegs, and not the beater-bar characteristic of the British machine.

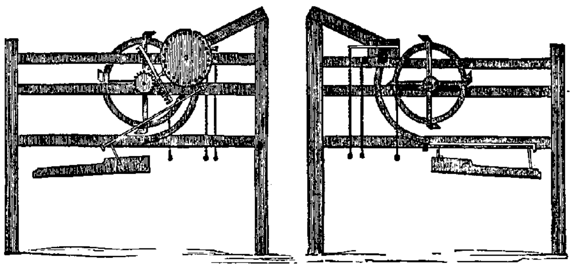


Fig. 4.3.—Meikle's original thresher
(Lincolnshire Magazine)

Whilst Meikle was carrying out his experiments, a number of other people were also engaged in the same field. Some of them were still attempting to thresh by means of the flail, and others were trying out drums of various descriptions.

There is no doubt that Meikle's work attracted widespread attention, and he continued to develop his ideas. In due course he made the machine illustrated in fig. 4.4, this being brought out

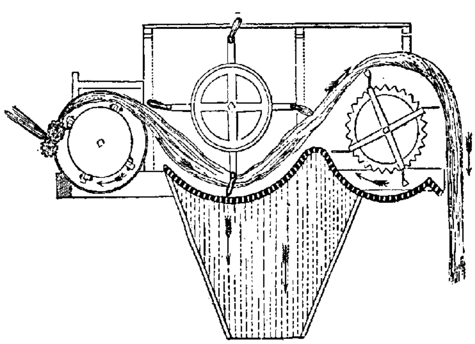


Fig. 4.4.—Meikle's improved thresher—section with peg drum and still without pegs on the concave
(Lincolnshire Magazine)

somewhere about 1789. It will be seen that here was some attempt to separate the grain and chaff from the straw. After having been threshed by the drum, the straw was swept twice over *semicircular grids*, the grain and chaff falling through the grid, whilst the straw was delivered by the *second shaker* over the end of the machine. It is interesting to note that small threshers with shakers on this principle —but with the addition of a dressing apparatus—are still occasionally to be found fitted into the barns of small farms in Scotland.

Big Manufacturers take up the Idea.

With the turn of the century, a large number of manufacturers were at work trying to produce a thresher. Amongst the firms which still exist there is *Ransomes, Sims & Jefferies, Ltd.*, whose predecessors were certainly making, or preparing to make, threshers

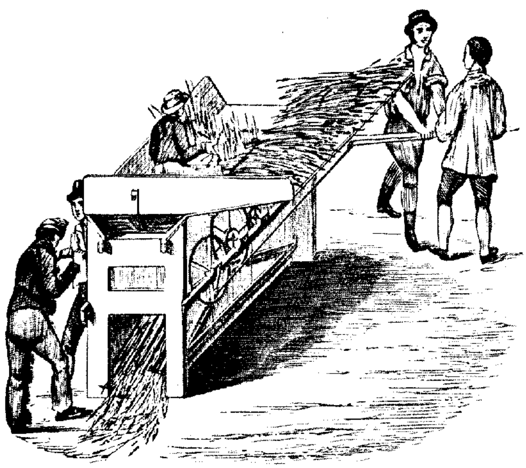


Fig. 4.5.—Hand thresher, 1842 (*Ransomes*)

in 1802. These machines were, of course, mostly driven either by hand or what was known as *horse-works* or horse-gear, that is to say driven by a device for transmitting power from a horse, or horses, travelling in a circle, to the drum shaft of the thresher. Fig. 4.5 shows a hand machine of date 1842. This required four men to provide the power, in addition to the feeder, &c.

By 1830, *travelling threshers*, which could be put on a wagon and transported from place to place, were coming into use; but the greatest advance in the practice of mechanical threshing took place after 1840.

Steam Engine revolutionizes Threshing.

In 1842, Messrs. Ransomes, Sims & Jefferies exhibited the first *portable steam engine* at the Royal Agricultural Society's meeting at Bristol. In the same year a combined portable steam engine and thresher was made by the firm of Tuxford, of Boston, and, after the introduction of the portable steam engine—closely followed by the *steam traction engine*—the number of makers increased and the thresher itself began to develop into the machine with which we are familiar at the present day.

The Royal Agricultural Society, in the years following 1842, held a number of *trials of threshing machines*, and modern names, or the names of firms who have recently discontinued the manufacture of threshers, appear in the list of competitors.

Between these years and 1880 were added the *dressing apparatus*, which included *awner or hummler*, *rotary corn screen*, &c., and in the last twenty years of the nineteenth century, threshers began to conform more or less to a standard type. In 1880, there were different sorts of drums, various types of shakers and of arrangement of dressing apparatus, but by 1900 most manufacturers were making substantially the type of machine which we use to-day. Details have, of course, been altered; considerable minor improvements have been made; *ball bearings* have become standard, except on slow-running spindles, and *pneumatic-tyred wheels* have been introduced. Largely, however, except for differences in minor details, the thresher to-day is the thresher of 1900.

The present-day portable type can be mounted on pneumatic wheels, steel or wooden. It is built on either a wooden or steel frame, and the internal parts generally are of wood, suitably braced and sheathed with metal, but sometimes are entirely of metal.

Steel-framed threshers, however, are by no means a novelty. In the eighties of the last century Messrs. Robey, of Lincoln, were making the steel-framed type. Whilst there is a good deal to be said for the steel frame, it also has its drawbacks, and probably the advantages of steel compared to wood, in British conditions, are about fifty-fifty.

Pneumatic tyres are, of course, a great advantage. The mill

may be moved faster from place to place; the strain on frame and undergear is not so great, and the power required to haul the thresher is less. The tendency to skid on icy roads is probably no greater than with iron wheels.

Features and Functions in Thresher Layout.

The thresher combines mechanisms which perform the following operations:

Threshing is accomplished by means of a revolving drum, partly enclosed by a concave, which is adjustable to meet varying requirements. The drum is usually 22 in. in diameter and is generally

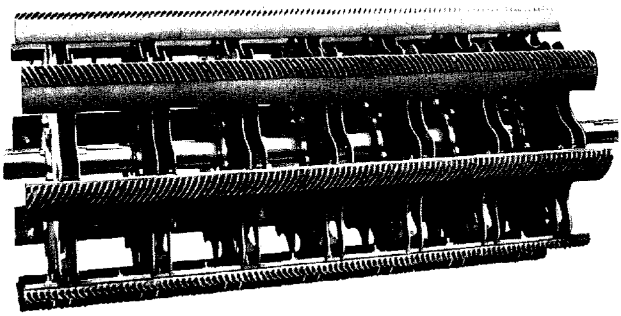


Fig. 4.6.—High-speed all-steel threshing drum
(*Tullos, Ltd.*)

provided with eight rolled-steel beaters, which have on their upper surface diagonal ribs, left to right and right to left on alternate beaters. The beaters themselves are secured to face-plates, which, in turn, are bolted to the drum heads. It is an advantage to have a wide face-plate as this tends to lessen the possibility of injury to brittle grain. It is also preferable to have a recess, or hollow, in the drum head at the foot of the face-plate, as this, with a deep face-plate, tends to ease feeding. The drum generally has a peripheral speed of 6000 ft. per minute, or thereby, and, whilst the speed recommended by different makers may vary a little, it may be taken for granted to be round about 1050 revolutions per minute. Figs. 4.6 and 4.7 show a typical *drum and concave,* and it will be

seen that the concave is a steel grating in two parts, made of longitudinal bars, through which are threaded steel wires. The two parts of the concave are mounted on three rods, and on the thresher side are adjustments by which the concave can be placed closer to, or farther away from, the drum. The spacing of the grating, or distance from centre of the wires, has to vary for different

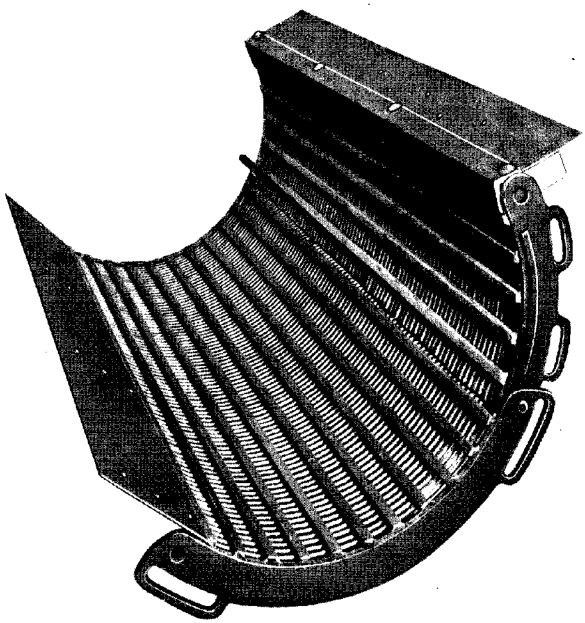


Fig. 4.7.—" Concave " for Tullos threshing drum

conditions; but it may be taken for granted that, so far as England and Wales are concerned, the concave wires should be pitched at $\frac{5}{8}$-in. centres. As these wires are $\frac{1}{4}$ in. diameter, the spacing between them is $\frac{3}{8}$ in. In Scotland, where most of the acreage is oats, and where conditions during threshing are generally not so dry as in England, the spacing can be wider.

In the matter of distance between concave and drum, this is entirely a question for each individual threshing. The closer the

concave is to the drum the greater is the power required, and the more risk there is of damaging wheat or barley. Consequently care should be taken that the concave is just close enough to thresh out every grain, and not close enough to do any damage. No good can come of too close a setting of the concave.

The art of good threshing is largely the art of good feeding. When the sheaf is loosened and fed into the drum, the more even the ingoing stream, the better will be the threshing. To feed a large compact mass leads to lowering of speed, bad threshing and dressing, no matter how good the machine may be.

The Corn leaves Drum and Concave.—As the spread-out sheaf comes through between the drum and concave, a considerable percentage of the corn is driven through the wires of the concave. Accompanying this corn is a lot of chaff, small pieces of ear, and bits of short straw. The balance which does not pass through the wires is thrown violently in an upward and forward direction above the shakers. Unless there was some check to this violent forward action, grain would be lost. Consequently, above the shakers there is provided a heavy check door, the flaps of which are usually made of heavy-gauge steel. This door is adjustable in height to suit varying conditions of crop, and its purpose is to throw the whole of the mass ejected from the concave on to the shakers as near to the drum as is possible.

In a travelling thresher there are usually *four shakers*, and these are generally mounted on two cranks in tandem. Their function, as the name suggests, is to shake out any grain which may be left in the straw. The cranks are usually made at angles of 90° one to another so as to give the greatest difference between the up and down position of two adjacent shakers. The speed of the shakers varies, with different makes, between 160 r.p.m. and 185 r.p.m., and they normally are between 10 ft. and 11 ft. long. From illustrations 4.8 it will be seen that the surface of each shaker is a grate formed with square splits set in diamond fashion. The shakers are provided with what are known as jumps or risers to check, and afterwards accelerate, the passage of the straw along their length; they thus shake out the grain. There is also one, or perhaps two, check doors or canvasses, in addition to the first door immediately beyond the concave.

Through the shakers pass the corn, the chaff, short pieces of straw, broken unthreshed ends of ears, especially barley, seeds, &c., and over the ends of the shaker goes the straw. As will be

understood, the shakers have a walking motion, but the rest of the internal moving parts of the thresher have reciprocating action. These parts which move back and forth are generally known as "*the shoes*". For purposes of balance there are two, which will be described later, and these two shoes receive their motion from the shoe crank, which is perhaps the most important moving shaft in the thresher. This crank is, as a rule, mounted on three ball-bearings, and the centre bearing is fixed to a steel bridge which runs across the thresher. The cranks themselves are usually four in number, two cranks operating the upper shoe, the other two the lower one. The bearings of the crank dips are usually fitted with ball-races, and the connecting-rods between those bearings and the shoes are, as will be seen from the illustration, of flexible timber —usually ash.

The speed of the shoe crank may run between 220 r.p.m. and 230 r.p.m., while the throw of the shoes may vary in different makes between 2½ in. and 3 in. The upper shoe, or tray, which carries on its end the second dressing apparatus, is so arranged as to catch the material which comes through the concave, and also that which comes through the shakers. This shoe or tray hangs on frictionless ash suspenders, and the same method of hanging is used with regard to the lower shoe. This lower shoe carries, first, the *cavings riddle*, which may be from 4 ft. to 5 ft. 6 in. in length.

A Look at the Riddles.—The purpose of the cavings riddle is, of course, to sift off the cavings—short pieces of straw, &c.—and let through the chaff, grain, dirt, seeds, &c. Most travelling threshers are fitted with a change of cavings riddle or, alternatively, the riddle is made in two parts so that a spare front section may be put in as occasion requires. The riddle itself is often made of wood, the board being about ⅝ in. thick, the holes being drilled and then countersunk half the depth of the board. This wooden cavings riddle works better perhaps than one made of sheet steel and pressed to the same countersunk shape as the wooden riddle. The disadvantage of the wooden riddle, however, is that there are so few timbers that will stand up to the boring of the large number of holes required without splitting. Even when the board is perforated and made up into a riddle, it is liable to split owing to climatic conditions, so that, in spite of its being a little coarser in working, the steel riddle is preferable.

In some makes of thresher, there will be found a delivery

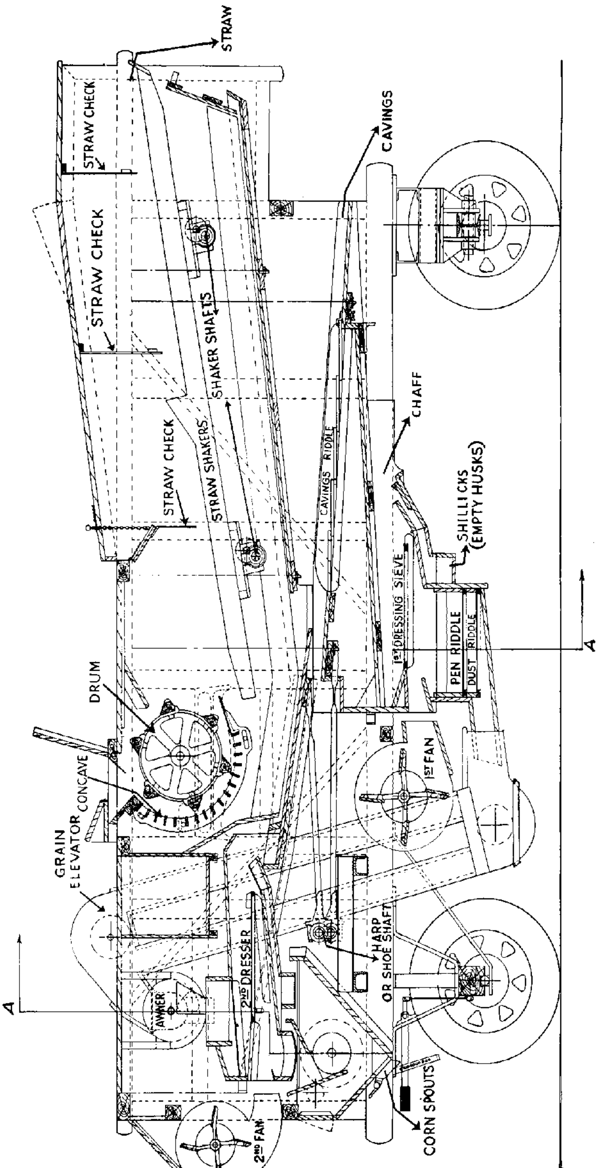


Fig. 4.8a.—Longitudinal section of modern portable thresher
(*Barclay, Ross & Hutchison, Ltd.*)

spout from *the first fan* which can, at will, deliver wind under the cavings riddle. The purpose of this blast is to keep the mass of material on the riddle " alive " so that the grain can sift to the bottom and pass through the holes. Generally speaking, except under very dry conditions, there is no great need for this blast of wind in this country, and its use sends a little chaff off with the cavings.

The first dressing fan, which provided the wind mentioned above, and also delivers a blast to the sieve next to be described,

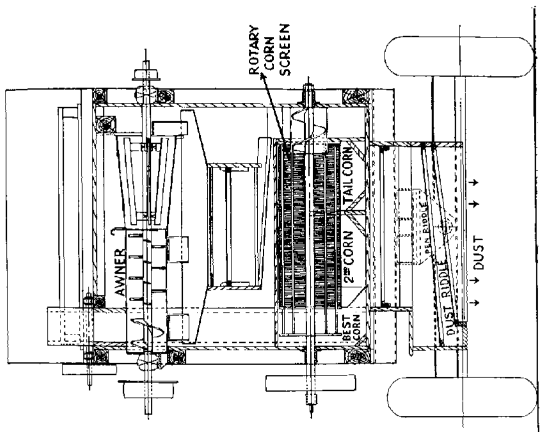


Fig. 4.86.—Cross-section of modern portable thresher

is usually 2 ft. or thereby in diameter, and can be made with wooden ends and a steel wrapper, or, alternatively, entirely of sheet steel. Wind shutters are provided at each end of the casings to increase or decrease the volume of the air current. The spindle runs from 600 r.p.m. to 800 r.p.m., varying according to the make of the mill, and is generally mounted on ball-bearings. Material which falls through the cavings riddle is delivered, as will be seen from the illustration, on to the first dressing riddle, and, as it is sifted along this riddle, receives a powerful blast of wind from the first dressing fan. Chaff, dust, and empty shells in the case of oats, are blown out of the machine, whilst the corn, small seeds and some heavy dirt still remain.

There are considerable differences in various makes of thresher at this point. As a rule, two different sizes of first *dressing riddle* are provided—one, say, $\frac{3}{4}$ in. diameter holes, the other $\frac{5}{8}$ in. diameter. Very often provision is made so that "the lay" of the riddle can be altered. That is to say, it can be raised or lowered at the end farthest from the fan. Beyond the riddle is what is known as a *tailboard.* This can be raised to check grain from being blown over, or lowered to allow more chaff to be blown over according to circumstances. In some mills, especially of Scottish manufacture, there is provided what is known as a "*shillick spout*", and the sectional illustration 4.8*a* shows this spout. Its purpose is to catch small, light grain blown over from the first tailboard and to prevent it, by means of a second tailboard, being blown with the chaff. Instead, it is thus delivered to the side of the thresher, and can be caught in a basket.

We now have left the grain, small unthreshed ends of ears, and, in the case of oats, what are known as "bosomed" oats. There will also be, under many conditions, heavy pieces of short straw, which have come through the cavings riddle. The whole is delivered on what is known as *the "chob" or "pen" riddle,* which lies across the machine. As shown, in the shoe is a diverting floor, which directs the grain so that it passes along almost the whole length of the pen riddle. Through the riddle comes grain, very small ends of ear, in the case of barley say two or three grains, and the "bosomed" oats, as well as the dirt. Over the riddle go the short pieces of straw, longer pieces of unthreshed ears, and over the pen riddle is the usual place where a mouse, now dead, comes after it has been passed through the machine. Immediately below the pen riddle is a seed riddle, also running across the machine, and a good deal of the heavy dirt and small seeds, still remaining with the grain, goes through this riddle. What does not go through is passed along a spout and delivered to *the corn elevator,* which takes the grain up again to the top of the thresher. The elevator generally has pressed-steel buckets, 5 in. to 6 in. wide. The head and tail pulleys are about 8 ft. diameter, and the speed varies from 80 r.p.m. to 100 r.p.m.

Corn Dressing Arrangements.

At the top of the elevator the grain usually goes in one of two different directions—to the awner, and to the second dressing apparatus.

Awner or Hummler.—The *awner* is commonly of the type shown in the illustration, and the spindle is generally mounted on ball-bearings. There is, first of all, a barrel, and that part of the spindle running in the barrel is provided with knives set at an angle. After that comes the conical section, and here the spindle is provided with beaters. As a rule there is a by-pass so that the grain can go through the cylindrical part and be ejected before coming to the conical structure. At the larger end of the conical section there is a door, which may be opened or closed, so as to keep the grain for a shorter or a longer time in the *hummler*, also known as the awner. In the hummler, oats are tailed, cleaned-up and made presentable for market; barley is awned much or little, according to the requirements of the owner; wheat is polished; " bosomed " oats are separated, and small ends of ears are threshed.

The awner is capable of many adjustments. As a rule, the revolving beater in the conical part can be slid nearer to, or farther away from, the large end, thus giving greater or lesser space between the beaters and the corrugated, inner surface of the cone. The door at the end can be opened or shut, thus varying the amount of grain kept in the awner at one time. Whether it by-passes the awner, or goes through it, the grain is delivered to the second dressing apparatus, which is mounted on the end of the upper shoe or tray, and has its own independent fan at the back of the thresher. This fan, the spindle of which is mounted on ball-bearings, has, as a rule, a case slightly smaller than the first fan, and is provided with similar wind shutters to the first fan.

The **second dressing apparatus**, as shown in the illustration, is of the Scottish type with only one riddle, under and through which the blast from the second fan blows. At the end of the riddle there is installed another " shillick spout ". This vent receives light and immature grains and delivers them to a corn spout, while the rest of the material—namely, dust, chaff, and light dirt, blown out by the second fan—goes into the thresher, along the tray under the concave, and is finally ejected by the first fan. This arrangement of a second dressing apparatus is not such as is followed by the English makers, who have two riddles

mounted one above the other, through which the blast blows, and, as a rule, have no " shillick spout ". The good grain, which has fallen through the first riddle and should now be cleared from chaff, is delivered to the **corn screen.**

Corn Screen.—This is a rotary screen or sieve inside which is fitted a " worm ", so that the grain travels from one end to the other. The sieve itself is a continuous length of wire wound into a spiral, and soldered to springs, at six or eight points on the circumference. By means of a screw in the centre of the grain shaft, the screen can be opened or closed, concertina fashion, thus giving more or less distance between the wires.

As a rule, there are two sizes of wire in a screen so that the part to which the grain is first delivered has a larger wire and a lesser distance between the wire than the second part. Through the first part come seeds and very tiny grain, usually known as *tail corn*. Through the second part comes larger grain, but still small and unmarketable. Over the end of the screen comes the heaviest and plumpest grain and, if the thresher has been properly adjusted, this should be ready to market.

The above description applies to *the portable thresher* used by contractors, and sometimes owned by an estate or the individual farmer. It is usually 4 ft. 6 in. wide, but occasionally is as much as 5 ft. In some cases it is only 4 ft. wide, and may be as little as 3 ft. 6 in.

In addition to this type of thresher, there are on the market a number of *light, portable machines* which make a special appeal to farmers in hilly and comparatively inaccessible districts. They are easy to transport and, while they will not, perhaps, deal with tangled, rough, damp crops with the same facility as the larger threshers, yet they will make a good job if competently used. These threshers are made in widths from 3 ft. 6 in. down to 2 ft. 3 in., and fig. 4.9 shows a machine of the latter width, which is intended for the small farmer.

The portable thresher which we have been considering is equipped with sieves and riddles to deal with wheat, barley, oats and rye, and, beyond the necessary changing of riddles, adjustment of the concave, regulation of wind, tailboards, &c., no further alteration is necessary except that, when threshing barley, it is sometimes advisable to "*pack the concave*" with one or two sheaves at its back. This prevents any half-ears which are broken off at the first impact of the drum from going through the concave wires

unthreshed. When this happens, in all probability these half-ears would escape with the cavings and be lost.

With modifications to riddles, ryegrass and most other grass seeds can be threshed. Turnip seed, beet seed, sugar-beet seed and mustard require, in addition to special riddles, what is known as a breast-plate to the concave; that is to say, a plate fitted to the inside of the concave, covering up the first four or five bars. Beans and peas require this same plate in addition to special riddles. In some cases, especially with very large beans, it

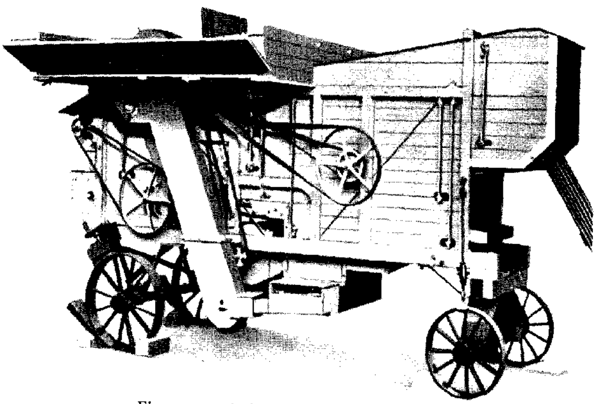


Fig. 4.9.—27-inch portable thresher (*Ransomes*)

is necessary to have special pulleys to reduce the speed of the threshing drum, keeping the remainder of the thresher at its proper speed.

Clover, both red and white, and other similar seeds can be threshed with an ordinary thresher. The job is so tedious, and such a lot of accessories are required, that it is far better to use one of the special clover-threshing machines which are made for this job. With the special machine, known as a *clover huller*, the seed can be threshed, drawn, and dressed at one operation, whereas it has to be put twice through an ordinary thresher, and a special fitting has to be mounted on the drum for the second operation as well as special riddles used in all parts of the machine. All this trouble, and its consequent waste, can be saved if the special clover huller is used.

Motive Power.

Only a comparatively short time ago, say up till about 1925, almost all travelling threshers, especially those 4 ft. and over, were driven by steam traction engines. With the perfecting of the

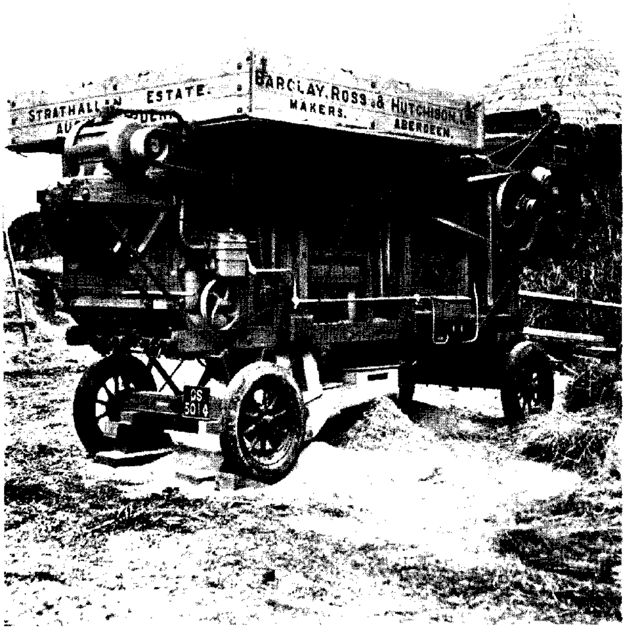


Fig. 4.10.—Portable thresher on pneumatic tyres fitted with Hornsby trusser and driven by an electric motor mounted on the back of the thresher

(Barclay, Ross & Hutchison, Ltd.)

internal-combustion engine and its application to farm tractors, the tractor has now become the almost exclusive motive power for the portable thresher.

The everyday farm tractor will drive a 4 ft. 6 in. thresher with ease, although it may not always be capable of pulling it on hilly roads. The advent of the pneumatic-tyred thresher has made the question of haulage very much easier, and practically any of the

medium-size farm tractors can deal successfully with the 4 ft. 6 in. thresher.

In several instances, electricity has been very successfully used to drive portable threshers. Fig. 4.10 shows such a thresher fitted with an electric motor mounted above the second fan, the motor being arranged on slide rails to take care of any extension of the driving belt; a special type of oil-immersed starter is used, and, both on large estates and amongst co-operative groups of farmers, this method of driving has given every satisfaction. It is, of course, a great advantage that there has to be no lining-up between motive power and thresher, and quite an appreciable amount of time is saved at each setting of the mill.

Refinements to Travelling Threshers.

To utilize to best advantage a travelling thresher quite a number of accessories can be fitted, and they chiefly are as follows:

Self-feeder.—One reason for fitting a self-feeder is that it functions as a safety device. To hand-feed properly is a skilled

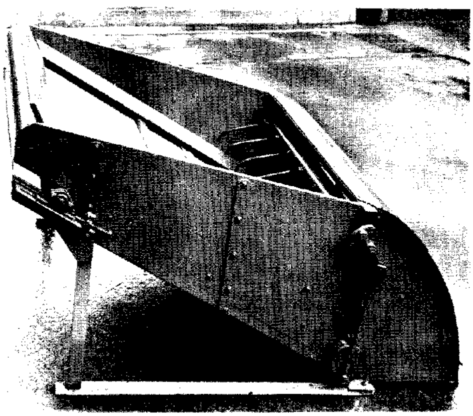


Fig. 4.11.—Self-feeder (*Tullos, Ltd.*)

job. With a good feeder there is a constant stream of the crop fed in such a way that there is no fluctuation of speed, and the drum never at any time runs empty. Bad feeding is one of the most frequent causes of bad threshing and dressing. At the same time, there is a certain amount of danger in hand-feeding and,

occasionally, one hears of the feeder being injured through the hands coming in contact with the revolving drum. A self-feeder, of the type illustrated in fig. 4.11, is so designed that, after the band securing the sheaf is cut, the sheaf is thrown on to the feeder and by it is regularly fed to the drum with no possibility of danger to the operator. A feeder of this description is of considerable advantage when unskilled and female labour is used.

Fig. 4.12.—Automatic feeder and band cutter fitted to Barclay, Ross, & Hutchison's thresher
(*Wm. Foster & Co., Ltd., Lincoln*)

The completely automatic self-feeder, as illustrated in fig. 4.12, receives the sheaves anywhere between the ground and the highest part of the stack. The sheaf is conveyed along the trough, the band is cut, and the sheaf is automatically fed to the drum. There is a regulating device which ensures that the feed of the crop to the drum is constant and no skill whatever is required beyond pitching the sheaves into the trough.

In most outfits, the straw is dealt with by an independent elevator, which will be described later on, but there are elevators which are attached directly to the thresher. One type is so constructed that it can be taken to pieces. The sides are hung on

the sides of the thresher; the floor of the elevator is stowed on top of the thresher, and the elevator belts are rolled up and packed above the cavings riddle. This type of elevator is arranged to traverse at an angle, so that straw is delivered either directly in front of the thresher, or at an angle up to say 30° on either side of it.

Another type of attached elevator, known as the Campion or " bottler ", is a wire ropeway with a grab. This works in conjunction with a pulley on a pole set up at some distance from the thresher. Straw is collected, or bottled, by the grab and automatically released at a predetermined distance by means of a stop, which can be set at any required point on the ropes.

Chaff-handling Apparatus.—The following features in threshers, according to requirements of the purchaser, can be arranged:

1. Provision to blow chaff out straight forward in front of the first dressing apparatus.
2. A collector to deliver the chaff at either side of the thresher at will.
3. A fan to pick the chaff up from above the collector and deliver it into a box, whence it is bagged in large sacks.
4. The chaff can be blown through steel or canvas pipes, to a distance from the thresher up to 150 ft.

Apparatus for Handling Cavings.—When straw is stacked by the straw elevator (see p. 123) the following can be fitted:

1. An extension to the cavings tray, by which cavings are delivered into the Haye's elevator.
2. A fan which takes the cavings from the collector and blows them to a distance from the machine up to say 150 ft. If desired this same fan can be arranged to deal with chaff as well as cavings, so that both these by-products are blown clear of the thresher together.

Apparatus for Handling Grain.—It has recently become more common for travelling threshers to be fitted with an automatic weighing and bagging device, the sacks being filled on a platform at such a height that there is no lifting when they are transferred to a cart or lorry. Fig. 4.13 shows a thresher fitted with automatic weighing machine. This mechanism, which is of the direct-balance type—not dependent on springs or compounded levers—can be

varied to suit the recognized bushel weight of the particular cereal being threshed. That is to say, it can be arranged so that a bag contains 168 lb. of oats or 240 lb. of wheat, and other crops in proportion.

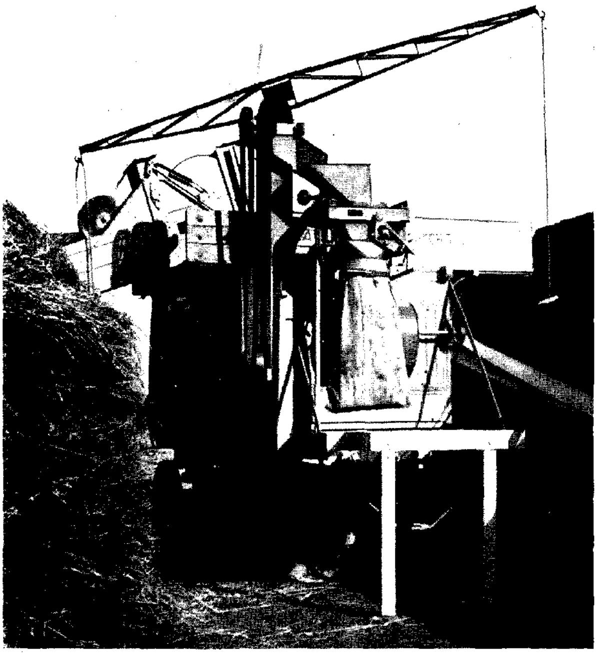


Fig. 4.13.—Automatic weigher and bagger
(Richard Simon & Sons, Ltd., Basford, Notts)

Straw Elevator.

The type of straw elevator generally used with a travelling thresher is what is commonly known as the Haye's pattern, which is illustrated in fig. 4.14. This is not a folding elevator, and is somewhat cumbersome both in transport and in setting. It has, as its greatest advantage, the trailing of the straw up the elevator trough. That is to say, during the whole of the time the straw is being elevated, it is imprisoned beneath the chains of the elevator

so that it is not affected by any wind that may be blowing until the very moment it leaves the elevator, when it can be comparatively easily controlled by the men on the straw stack. This type of elevator, of course, raises and lowers, and is generally fitted with what is known as angle gear, so that it will deliver the straw at an angle from the thresher as well as straight forward.

Another type of elevator is the folding pattern generally used for stacking hay, but it can also be used with the thresher. It folds into a very compact space for travelling, is light, and not

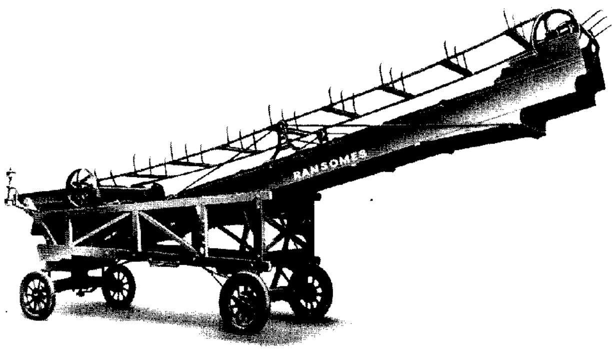


Fig. 4.14.—Straw elevator, Haye's pattern
(*Ransomes*)

cumbersome. When setting it can be set to deliver straw at an angle from the thresher as well as straight ahead. Its disadvantage, compared with the Haye's pattern, is that the straw is carried on top of the tines, and is, therefore, more liable to be blown away during a high wind.

Straw Trusser.

The straw trusser bundles or bunches the straw in the same way that a binder makes a sheaf. In fact, the straw-trussing mechanism is practically the same as the sheafing mechanism on the binder. The type of straw trusser commonly used in this country is what is known as the hanging type. That is to say, it is fitted to the thresher, and is not a portable on its own wheels. Fig. 4.15 gives an illustration of the hanging trusser, while in fig. 4.10 the trusser can just be seen.

Straw trussers were, for a number of years, made with what is known as raising and lowering gear. With this gear the trusser was raised out of its working position to such a height that it cleared the backs of the horses which were pulling the thresher. This raising and lowering gear was also necessary when steam

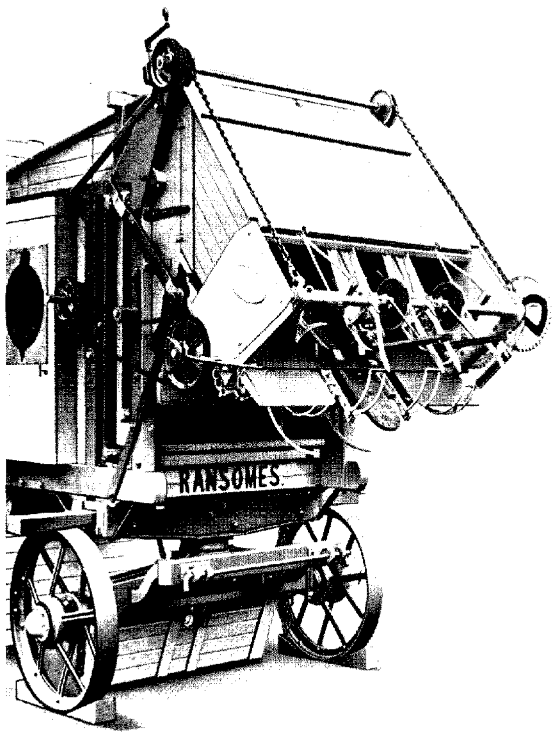


Fig. 4.15.—Hornsby straw trusser on a Ransomes thresher

traction engines were used for haulage. Now that tractors are used and the height from the ground is so much less, the raising and lowering gear is not necessary.

The main object in using the trusser is that the straw is under control, the size of the truss can be varied to suit circumstances, and the truss can be carried about without losing a great deal of

straw, and any small expenditure on binder twine is amply repaid by the convenience of the truss or bunch in handling.

Balers.

Where it is necessary for the straw to occupy very little space, i.e. when a large quantity has to be stored in a small building, or where straw has to be sent by rail, the baler is used, and fig. 4.16 illustrates such a machine. When threshers were driven by steam

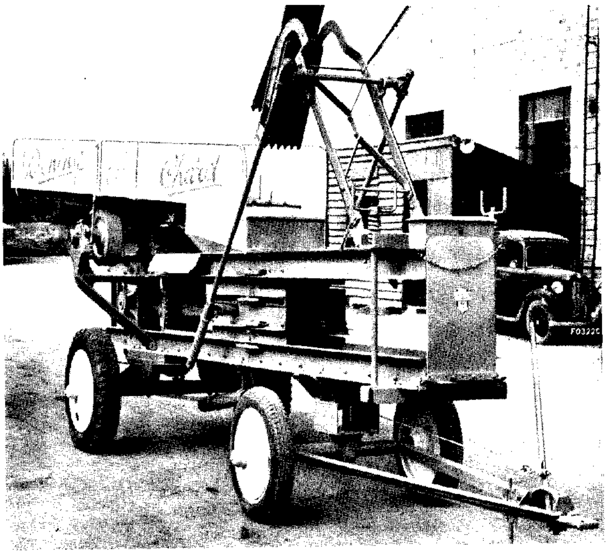


Fig. 4.16. Straw baler (*Dening & Co.* (1937), *Ltd., Chard*)

engines, it was usual to drive the baler from the drum shaft of the thresher, the drive being so arranged that the pull of the baler belt was opposed to the driving belt. With the lesser average power and decreased flexibility of the tractor drive, it is now common practice to drive a baler by means of an independent tractor. With this drive as a rule the baler is set crosswise to the thresher. When properly handled, the average baler will deal with all the straw that comes from a 4 ft. 6 in. thresher. The bales are tied by wire ties and are of such a size and weight that they can be handled by one man. Balers are also manufactured with an I.C. engine mounted on the baler frame and forming a self-contained unit.

Stationary or Fitted-in Threshers

The development of the *fitted-in thresher* advanced parallel to that of the portable type, but its use was more prevalent in Scotland than elsewhere.

In the first place, threshers were installed more rapidly in that country, especially north of the Forth, because water power was so abundant there. The existence of many rivers and streams had led to the erection, centuries before, of *meal mills* in all parts of the country and, by the time threshers were being introduced, in the early years of the nineteenth century, there was already a class of skilled millwrights thoroughly conversant with the *application of water power* to machinery.

The staple food of country people in those days was oatmeal. Practically every parish had its meal mill, or mills, and as a rule the farms were " thirled " to the local mill. That is to say, it was one of the terms of the lease that the oatmeal required on the farm should be ground at this particular mill. Under these circumstances the choice of water power to drive the thresher was an obvious one, and this meant that the thresher had to be fixed in one place. In course of time, practically every farm had its own thresher. By no means all of these, however, were driven by water. In some cases the power was provided by horses, and there are records of one or two threshers being driven by windmills.

The possession by each farmer of his own thresher had, and still has, numerous advantages. Threshing could be done on days when other work was impossible or inconvenient. The fact that the crop could be taken close to the thresher, i.e. on to the sheaf loft, at some time other than when the thresher was actually working meant that less concentration of labour was required. The thresher being inside the farm premises meant that the corn, straw and chaff were close to where they were to be used. There was no need to borrow labour for threshing, as is often the case when a travelling thresher is to be used. Apart also from the question of convenient power, there were—and still are—considerable advantages in the possession of the fitted-in thresher.

We have a great deal of evidence from Scotland that farmers adopted very quickly the practice of having their own threshers. In " The New Statistical Account of Scotland ", published in 1842, the following are amongst a number of other recordings:

Parish of Ellon, Aberdeenshire.—"Threshing mills have been erected in almost every instance in which the farm is of any suitable extent. Indeed it would be scarcely possible to procure servants willing to undertake what was wont to be described a heavy labour."

Parish of Leochel-Cushnie, Aberdeenshire.—"There are now 45 threshing mills in the Parish, 19 driven by water and 26 by horse." (There were then 104 horses and 18 working oxen in the Parish.)

Naturally, many of these mills were small. A large percentage of them were built to the water and not to the farm. That is to say, the width of drum depended rather on the amount of water which could be brought to the wheel, than on the size of mill required by the farm. They were, in the majority of cases, of the type first developed by Meikle, and had a peg drum and concave with rotary shakers. There may or may not have been primitive dressing apparatus, but it is probable that the dressing was done by tossing up the grain in a draught between two directly opposed barn doors. It is to the credit of the old-time millwrights that, even now, in isolated instances, some of these threshers are still working. Dressing apparatus has been added to them, and they are, perhaps, now driven by an internal-combustion engine instead of by the old water wheel, but one or two of them continue to work by the water wheel.

Where water power was insufficient, large farmers put in a *steam engine* and installed a larger mill. Very often this mill was actually built on the site at the time the steading was erected. There are a number still in existence, which could not be taken to pieces and re-erected in another place without taking down some of the principal beams in the building. The introduction of the *internal-combustion engine* in the eighties of the last century, raised the power limit, and consequently increased the size of the threshers used. With this additional power it was easy to add to the performance and output of the threshing plant and thus save labour and time.

It is the opinion of the writer that the day of the fitted-in thresher is by no means over. It should be remembered that a large percentage of the cereal crop in Britain, particularly Scotland, is oats, and that the fresh straw of this cereal is something which cattle readily eat, and on which fodder they thrive rapidly, whereas, if the straw has been threshed for five or six weeks, animals will hardly touch it. As farm economy depends largely on providing to stock fodder that they will relish, this is a real point in favour of the fitted-in thresher.

The modern installation may have a drum of anything from 4 ft. 6 in. down to 1 ft. 6 in. wide. The large thresher is usually " full finishing ", as has been described in the details of the portable thresher in the previous section (figs. 4.8 *a* and *b*.)

The following are *labour-saving appliances* usually fitted to stationary threshers.

Straw Carriers.

Quite often the thresher is fitted with a buncher or trusser into which the straw can be delivered direct from the shakers, if it is intended to bunch it. If, however, the straw is required for bedding-down cattle, delivery is not made to the buncher, but to a straw carrier, which runs over the top of the buncher. This carrier, which is of the trailing type, bears the straw forward from the thresher and drops it through any one of a number of doors, thus putting it where required by the operator. Also the straw carrier can change its direction. Frequently a steading will be built in the shape of a " T ", the mill standing in the vertical member of the T and the straw barn running along the head of the T. In this case the carrier is arranged so that straw can be delivered to one side or the other of the barn with little adjustment of mechanism. It sometimes happens—especially where a mill is fitted into a barn that has previously had water power in it and is on low ground—that part of the steading is a distance away on higher ground. In this case it is possible to fit a *straw blower*, which will take all, or a proportion of, the straw threshed by the mill and blow it into the straw shed as far as 250 ft. away from the blower. This blower requires power, but it puts the straw where it is needed. For chaff or cavings, or chaff alone and cavings alone, blowers can be fitted to blow one or the other, or both, of the above products into a chaff box, which is usually built in the vicinity, or corner, or roof of the cattle court. The chaff is put into the court and what is not eaten by animals is trampled into dung. To hold the grain, the granary, or grain loft, is usually somewhere near the mill barn, and it is now the practice to provide an elevator and grain carrier to deposit the corn where required.

Types of Grain Elevators.—The elevator is of the *bucket type*, and the carrier one of three forms:

1. *A Travelling Band* of cotton fabric, on which the grain rides and is taken off by a scraper at predetermined points.

2. *A Trailer.* This is a trough over which runs a band provided with scrapers, by means of which the grain is scraped along the trough. Doors are provided to let down the grain where required.
3. *A Shaking Spout.* This is what its name implies. A spout, slightly inclined, and shaken back and forth by a crank. It is a method of conveyance not to be recommended, except under certain circumstances, which will be dealt with later.

It is sometimes advantageous to elevate the second grain (" seconds "). Usually this is used on the farm as bruised corn, and very often the grain elevator is made double—one leg takes the good corn, the other leg takes the second grain, which is delivered to a hopper fixed above the corn bruiser.

It will be readily understood that a threshing machine with these accessories requires very little man-power to get through a lot of work. The actual feeding of the machine has, of course, to be done, but the straw requires only one or two, at the most two, men to position and tramp. The chaff and cavings require no labour whatever, and the grain carrier needs no looking after. Except for a very occasional changing of a bag for the dross corn, no other attention is required. In popular parlance this attainment may be hailed as " threshing without tears ".

Wonderfully Efficient Small Models.

As indicated previously, fitted-in threshers are by no means all of a large size nor are they by any means all " full-finishing "

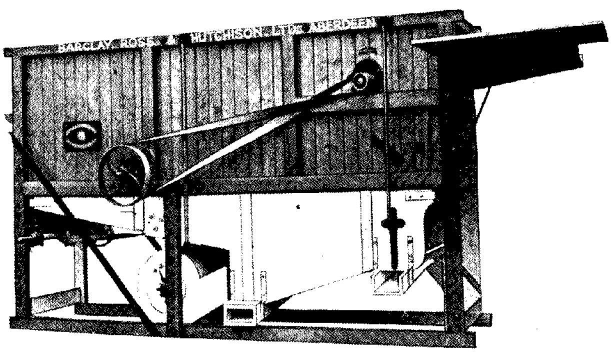


Fig. 4.17.—Semi-portable single-dressing thresher

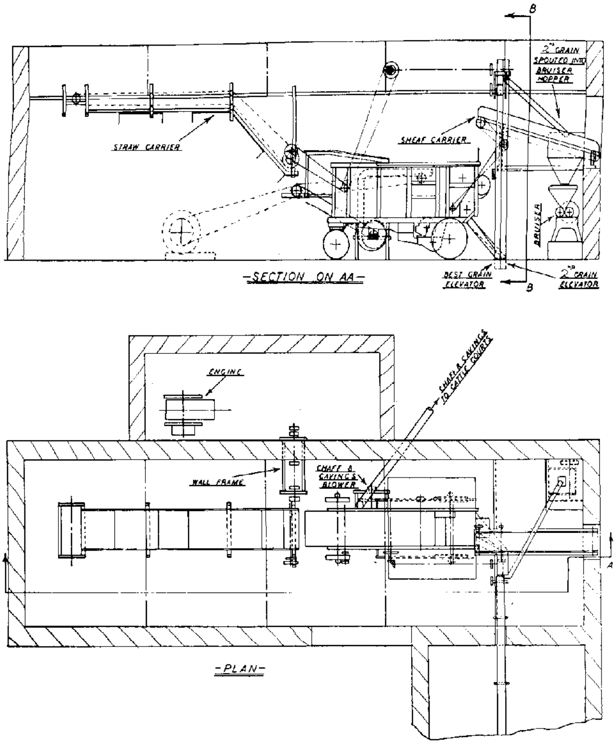
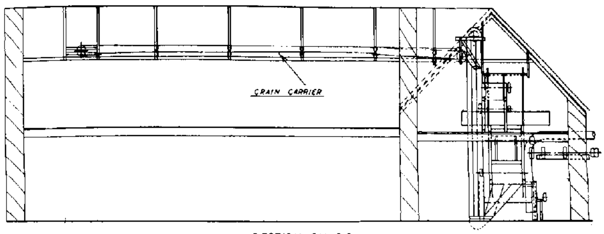


Fig. 4.18.—Typical arrangement of thresher and accessories in barn

(Barclay, Ross & Hutchison. Ltd.)

threshers. Fig. 4.17, for instance, shows a *small single-dressing thresher*, 1 ft. 6 in. wide, requiring only 3 h.p. to drive it, which can work in a barn 8 ft. wide and 12 ft. long and 10 ft. high, and will thresh approximately 16–20 bushels of oats per hour. There are very large numbers of smaller threshers working in Britain, particularly Scotland, and fulfilling every requirement of their possessors. These single-dressing threshers make a good job of oats—very often as good a job as the travelling mill, due to the operator being the owner. It may be taken that " full-finishing " threshers are built down to 2 ft. 6 in. in width, while single-dressing threshers are made up to 2 ft. 6 in. wide. It is in connexion with



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single-dressing threshers that the shaking spout for grain conveying, previously referred to, may perhaps justify its choice against either a travelling band or trailer.

The single-dressing thresher is not fitted with a sizer, or rotary screen, but very often the farmer may wish to preserve some of his own grain for seed and, naturally, desires to sow the plump full-size grains only. For this purpose it is possible (and it is frequently done) to fit a piece of perforated steel (with rectangular holes) into the bottom of the shaking spout, so that the small grain falls through, whilst the plump corn is carried along to the end. In this way the farmer is enabled to keep his own corn for seed and has the satisfaction of sowing only plump full-size grain.

Barn Threshers have come to Stay.

The enormous increase in cereal acreage, due to the war, has led to a corresponding addition to the number of travelling threshers. Yet there seems to be no justification for thinking that the fitted-in thresher will disappear in course of time. Rather are there indications that the travelling thresher will be incorporated in a similar function.

Already in a number of cases, the barn has been arranged so that a portable thresher can be run into it and coupled up with all the labour-saving devices for disposal of straw, chaff, grain, &c., described above, and, when necessary, the same mill can be taken outside and used as a travelling machine. This method has the advantage that there can be a big thresh immediately after harvest; the thresher can then be put into the barn to be used weekly, or fortnightly, for the routine " thresh for straw ". When the cattle go to stay outside for the grazing season, the thresher then can be

taken out into the cornyard to thresh the remainder of the crop, as the straw is not needed immediately on the premises. Fig. 4.18 shows an outline drawing of a portable thresher arranged for taking in and out of the barn, and for coupling up with the following accessories—straw carrier, double grain elevator for both first and second grain, grain conveyor, sheaf carrier to carry the sheaves from the opening in the barn wall to the feeder's hand, and the chaff blower. It will be noted that in this case the motive power is an internal-combustion engine, which may have been fitted to drive the fixed mill, and was presumably in the steading before the portable mill was purchased.

In all probability, unless our farm economy changes greatly beyond what can be foreseen at the present moment, the fitted-in individual thresher will still have a secure place on the farm.

The motive power of a barn thresher depends entirely on circumstances. Where an ample supply of water and a good wheel exist, there is no better drive for a threshing machine. When there is a good head of water, a turbine makes a perfectly satisfactory drive, and in many parts of Scotland turbines have been driving threshers for a number of years. Internal-combustion engines are very widely used, and, since the introduction of the small-power Diesel engine, the cost of driving a thresher for the ordinary work of one farm amounts to only shillings per annum. Where electricity is available, an electric motor may be used. This may drive on to a line shaft, the drive then being taken to the thresher as well as the other barn machinery. It may drive direct by belt to the drum shaft of the thresher, or it may drive by means of " Vee " ropes, either to shafting or direct to the main shaft.

Barn Machinery Units

There are a number of small machines which may be generally grouped under the heading of " barn machinery ". This is not to say that they are always used in a barn, but only to indicate that they are usually to be found in this department. Mostly these machines would come under the classification of food-preparing machines, but, again, there are exceptions.

Winnower is an Old Contrivance.

The winnower, or barn fan, still extensively used, is probably one of the oldest pieces of farm equipment. The use of a draught

of wind created by means of a fan was practised many generations ago for the cleaning of grain. Fig. 4.19 shows a large-diameter slow-running fan which gives a " mellow " draught of wind, this wind being, as a rule, directed under two sieves contained in the shoe of the winnower. These sieves are usually of woven wire, and the movement given to the sieves is a rotary motion, similar to that used by a person operating a sieve, rather than the reciprocating action generally found in agricultural machinery. The barn fan

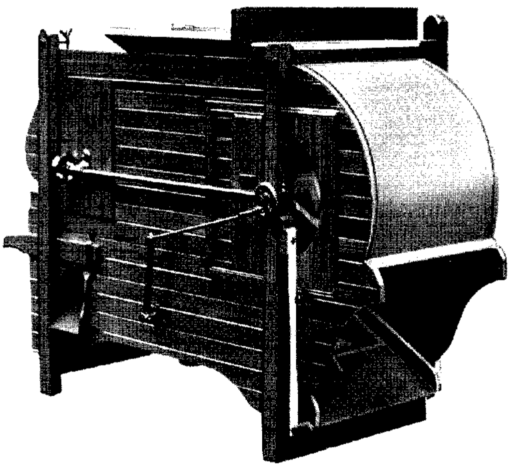

Fig. 4.19.—Winnower
(Robert Boby, Ltd., Bury St. Edmunds)

is used to redress grain after it comes from the thresher (where a full-finishing thresher is employed this redressing should not be necessary); to dress seed grain; to separate out small seeds which may have been left by the finishing thresher; and generally to improve poor samples of grain. Barn fans are, of course, much more frequently used in those districts where the thresher, either fixed or portable, has only a single-dressing apparatus. The barn fan itself is designed for hand operation and may be carried from place to place. Under certain circumstances it is an advantage to couple the machine up to an existing line of shafting in the barn, thus eliminating the monotonous labour of operating it by hand.

Chaff-cutting Equipment.

The chaff or hay cutter, a typical example of which is illustrated in fig. 4.20, does what its name suggests. It cuts up hay or straw into short lengths in order to make it more easily masticated and more palatable for the animal to which it is to be fed. The length of the chop may be varied within considerable limits,

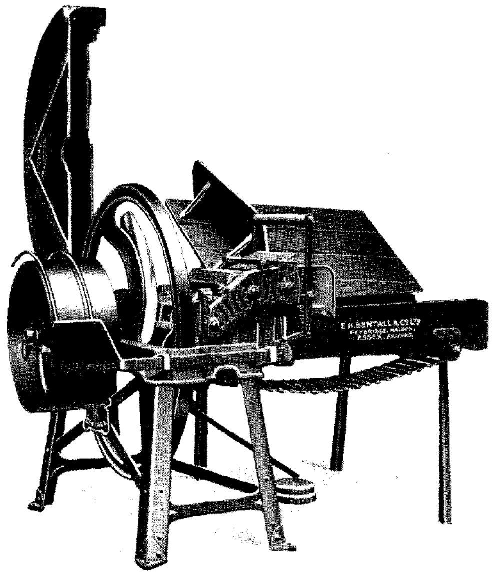

Fig. 4.20.—Chaff cutter
(E. H. Bentall & Co., Ltd., Malden)

e.g. one popular make gives the longest length as $1\frac{1}{2}$ in., the shortest length as $\frac{3}{8}$ in., with $\frac{3}{4}$ in. lengths between. The machine can be obtained either for manual operation or power-driven. The cutting wheel, which is a heavy flywheel, is provided with knives, generally two in number. The simplest form of feed is by hand, but there are obvious dangers in this style of operation. Usually some kind of web-feed is provided, while in addition there is, as a rule, an automatic safety device which knocks off the feed if there is too

big a volume of material or a foreign substance put into the machine. By law, the knife wheel has to be enclosed as a provision against accident. The machine illustrated is for *power drive* and is fitted with fast-and-loose pulleys, also with feed table, safety lever, and automatic safety clutch.

Corn Crushers or Bruisers.

Bruised corn has a considerable advantage over whole corn as an animal feed and, although the degree of bruising varies in different parts of the country, generally speaking bruised corn, especially bruised oats, is used all over Great Britain. In Scotland

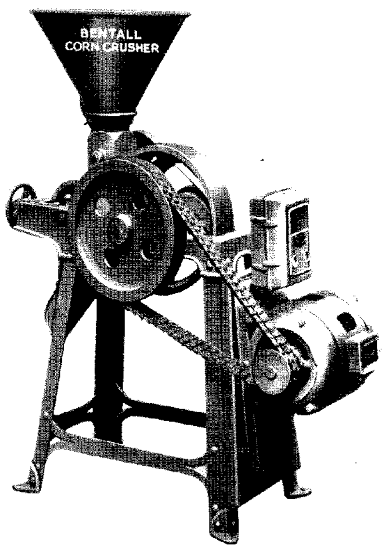

Fig. 4.21.—Bruiser (*Bentall*)

oats are crushed rather than bruised. In other parts of the country the amount of pressure used on the outfit may be considerably less. *Corn crushers, or bruisers,* in their small sizes can be supplied for hand power, but hard bruising of any grain by hand power is a laborious task, and they are mostly power-driven. As a bruiser alone the type of machine illustrated in fig. 4.21 is probably the

most popular. The bruising rolls are of different diameters, the larger roll being driven, whilst the smaller roll rotates by friction from the large roll. The pressure screw is cushioned by means of a spring, and the degree of bruise depends upon the pressure put on this spring. Above the two rolls is a small feed roll which controls and evens out the stream of grain going to the bruising

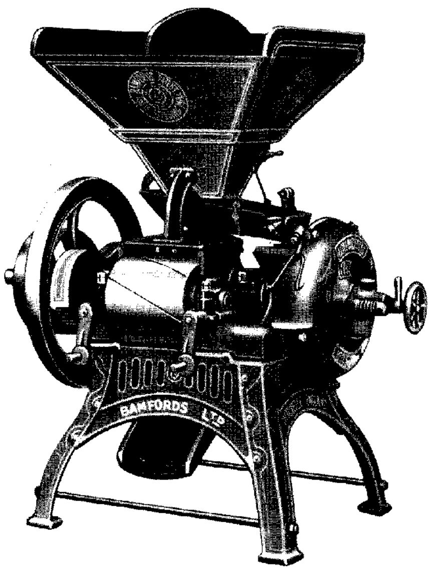

Fig. 4.22.—Crushing and grinding mill
(*Bamfords*)

rolls, while the quantity is regulated by means of a slip above this feed roll. The type illustrated in fig. 4.21 is shown driven by its own electric motor, but these machines can, of course, be driven with equal facility from line shafting or direct from an internal-combustion engine.

Another type of bruiser or crusher has rolls of equal diameter. In this case the rolls or cylinder are geared together, the pressure device being of the same description. Either of these two types of machine may be had with a *grinding attachment*. Where this is

fitted there are, of course, two hoppers, and it is not usual to use the grinding attachment at the same time as the bruising part of the machine. Fig. 4.22 shows the type of combined bruiser and grinder mentioned above.

Versatility of Hammer Mills.

Where power has been available *hammer mills* have been utilized for a number of years, but it is only since the coming into general use of farm tractors and/or of electric power on farms that hammer

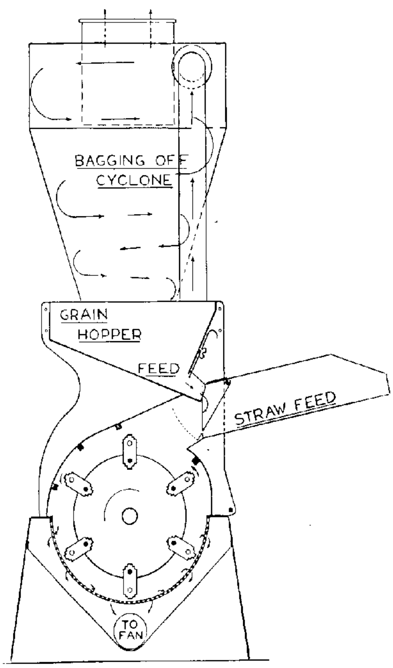

Fig. 4.23.—" Hammamac " mill, sectional view of " Victory " model
International Crushing and Grinding Equipment, Ltd., London)

mills have been regarded as farmers' machines. The principle of its mechanism is probably well enough known—a rotor carrying a number of steel hammers, which are pivoted to it, rotates inside a perforated screen, the size of hole in the screen regulating the

size of product produced. Fig. 4.23, which shows a sectional view of a popular model, gives a clear illustration of the mechanical layout, while fig. 4.24 illustrates the outside view of the machine. The hammer mill will do practically anything that can be done by bruisers and grinders. It will "chaff" straw and hay, and, unlike the chaff cutter, to a certain extent will bruise the chaff and make it more palatable; it will grind beans, mixed beans and

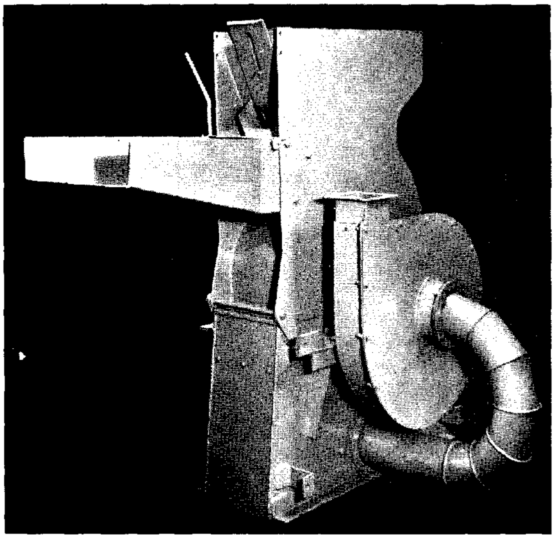

Fig. 4.24.—"Hammamac" mill, standard model No. 2ss

oats, or, in fact, any mixture of grains; it will make meal for pigs and will also produce a fine meal for poultry and chick feed; it will make a grass meal, and will also produce a wholemeal wheat flour if required. This range of work can be produced by the same machine simply by changing the screen.

In the operation of a hammer mill it is essential that there should be sufficient power, and it is also important that there should be adequate speed. The output and quality of work will suffer if the power is not up to requirements and if the speed is not the correct one.

There is very little to go wrong with a hammer mill so long

as stone, or metal, is not introduced with the material to be ground. In most makes the hammers are reversible. They are generally made of material to a special analysis and the screens are all of wear-resisting material. A range of screens is usually provided, but this selection may not be suitable for everything that any particular user may require, and other sized screens can always be obtained from the maker.

Hand and Power Turnip Cutters.

There are three types of turnip cutters made and sold for the purpose of slicing and " fingering " turnips and swedes for animal food. The first of these machines, known as the " *Gardner's* " turnip cutter, is illustrated in fig. 4.25. As will be seen, the cutting

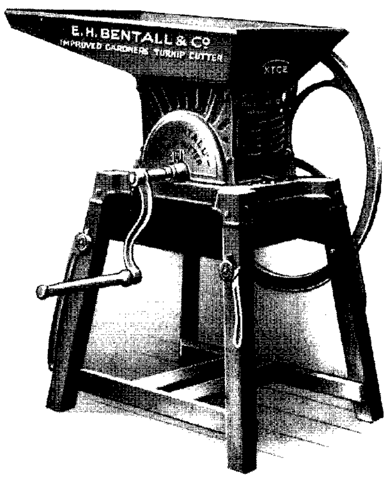

Fig. 4.25.—Gardner's type turnip cutter
(*Bentall*)

mechanism is a barrel fitted with knives, this barrel being attached to the main shaft of the machine, which has at one end a heavy flywheel. Turnips are loaded into the hopper, and their weight carries them down into contact with the cutting barrel. Such a machine, subject to the provision of the proper knives on the barrel, will slice, cut large " fingers " for cattle, and small ones for

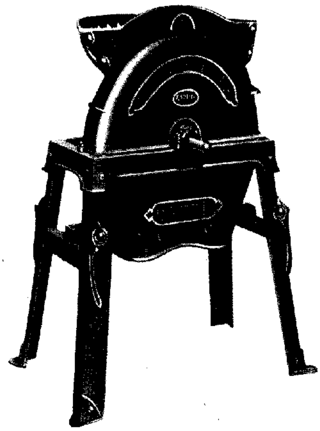

Fig. 4.26.—Root cutter (*Bentall*)

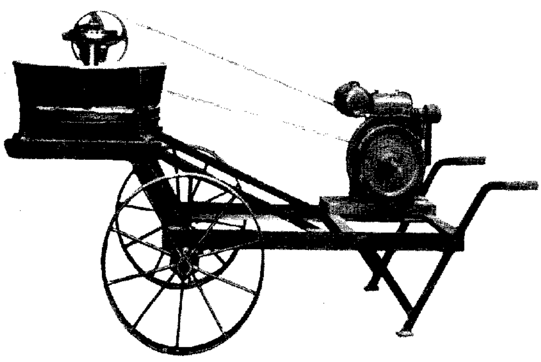

Fig. 4.27.—Horizontal turnip cutter
(*Barclay, Ross & Hutchison, Ltd.*)

sheep. It can be driven by power as well as by hand, and is so arranged that it can be carried from place to place.

The next type of machine is the *vertical-disc cutter*, illustrated in fig. 4.26. As will be quite readily seen, the cutting medium in this machine is a vertical disc mounted on a central shaft. This shaft may be driven either by hand or by power. The hopper is of such a shape that the roots are fed into a position relative to the disc so that they must be cut. With suitable knives and plates this machine will cut four or five different sizes of " fingers ", and can also be fitted with slicing knives. It can be driven by either hand or power, and is frequently fitted with a cleaning attachment in order to knock as much dirt as possible off the roots before they come in contact with the cutting knives.

The third type of machine is generally known as the *horizontal turnip cutter* and is shown in fig. 4.27. This machine can be worked by hand, but is more generally used with a small engine or with an electric motor. The illustration shows a small engine fitted. The cutting disc of the machine is arranged horizontally forming a bottom to the hopper. The disc can be fitted either with slicing knives or with combined slicing and fingering knives. A machine of this description, driven by an air-cooled engine, is of considerable value amongst sheep. With the engine air-cooled, there is no necessity to draw the cooling water in frosty weather. The machine can be shifted from place to place with comparative ease, and a large amount of work can be done in a short time.

Silage Cutters and Blowers.

Not every farmer makes silage, and even those who do make it may not do so every year. Further, a large quantity of very good ensilage is made in pits or in temporary silos. Therefore the silage cutter is not found on the average farm. Where, however, there is a high concrete or wooden silo installed, it must be used. It is a machine (fig. 4.28) which can be conveniently driven by the average farm tractor fitted with a power-take-off pulley. It is built on the lines of a chaff cutter, but is of much greater strength. The feed of the material into the cutter is mechanical, and a large cutter wheel, as well as being fitted with cutter knives, is equipped with paddles; the cut material may be blown through a steel pipe into the tall silo at a height of 50 or 60 feet.

Fig. 4.28.—Ensilage cutter (*Massey-Harris*)

Dawning Era of Grain Drying

With the vastly increased cash importance of cereal crops and the coincident tendency to think in terms of Combine harvesting, it seems likely that we are entering an era of the intensive use of grain driers. Especially is that true of world cropping areas where the atmosphere is as humid as is that of Britain. Grain, seemingly dry to touch and in appearance, may contain a percentage of moisture that will render it quite unfit for even brief storage.

It should be noted also that even if there had been no Combine harvesters deluging mills and stores with " soft " grain, the needs of the barley crop alone in Britain would still have driven us to use, sooner or later, grain driers—an advanced form of the idea, the germ of which was the crude drying sheds of a generation ago. Twenty acres of barley are of great value to the grower; but to the State the same area is worth, in alcohol duty, about £20,000 at the present time and, if the farmers are interested in the expanding use of crop-saving driers, the State should not be slow to encourage them.

More than any other cereal, barley deteriorates rapidly in colour, quality and value if the weather is damp (as it often is), and, if the grain drier comes to the rescue of this golden crop as

it leaves the Combine, or even the ordinary " binder ", it will be a front-rank investment. The straw of this crop is only of little importance normally, and there is no need to risk the grain to preserve palatability and nutritional properties as in the case of oat straw.

The job of the grain drier is to remove enough moisture—say, 4 to 8 per cent according to content—to bring the moisture content of the corn down to not more than 14 per cent, so that it can be stored with safety. Slightly higher percentages are permissible if the owner of the grain is prepared to see that it is regularly turned afterwards when stored in a shallow bing on a wooden floor.

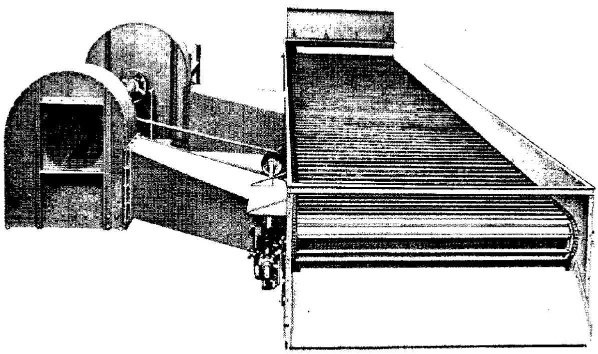

Fig. 4.29.—Grass and grain drier (*Ransomes*)

While certain endless-belt grass driers are easily adaptable to grain drying those (fig. 4.29) specially for drying grain show marked differences in design compared to the grass models. They may be grouped under three heads: (1) those in which the drying grain passes down through the outfit by controlled gravitation; (2) those in which the corn moves horizontally by conveyor; and (3) the batch style of drier. The " wet " corn in the case of vertical driers is elevated to the feed hoppers by either blast or by bucket elevators.

In the vertical models the wet grain falls from the feed hopper, filling hollow walls, both surfaces of which are perforated to allow a blast of hot air to enter at one side and work through the grain and out at the other wall. The downward speed of the corn between the drying walls is regulated according to the amount of moisture

to be evaporated, and is controlled by the rate at which the conveyor is adjusted to remove the dried grain at the base.

Safe Temperatures.

Temperatures recommended in makers' instructions should be carefully adhered to because there are vital distinctions between what is required for the respective degrees of drying called for in dealing with milling and seed consignments. Seed and malting grain must on no account be overheated; nor can one particular range of temperatures be given, as this varies according to moisture content of the grain prior to drying, the higher the water content the lower the temperature employed and vice versa. As a rule, regardless of the moisture content, maltsters favour low drying temperatures, not over 110° F. For this reason, the same efficiencies in evaporation and general performance cannot be expected in grain driers as are looked for in grass-drying outfits. Average costs per hundredweight of grain dried should work out just over 7*d.*, half of that being made up by interest and depreciation.

Representative *types of grain driers* include Ransomes, in which a layer of grain moves along by conveyor while drying; the Kennedy and Kempe, the Mather and Platt, and the Steele driers with their vertical-elevator systems, and various horizontal-tray (batch) driers, characterized by low first cost coupled with low efficiency.

At the start of the war a memorandum was sent to the Ministry of Agriculture by a student of the farming situation, urging the installation of central grain-drying plant in each parish, particularly in those areas where barley growing was precarious because of damp harvests. But the need has not disappeared with the end of the war, and one might even go a little further and urge that a grain drier should be operating for the benefit of each suitable-sized group of farms, co-operatively. (Since this was written, the Ministry of Agriculture has encouraged financially the installation, on a co-operative basis, of grass driers.)

Equipment for Drying Grass

Since the dawn of time man has had a respect for a carpet of luscious grass. A Scottish farmer was being piloted round among the tombstones so that he could view the better the lovely architecture of a famous abbey. His guide failed, however, to get him

to desist from riveting his attention on conditions underfoot: " What a dandy bit of grass for an unwell cow." The agricultural tourist was right. There were wonderful food and tonic values in sweet young grass, and more even than were dreamt of by him. Newly cut, young grass has a protein content comparable with cow's milk, and the protein of this grass is also of high biological value.

While for decades it was recognized that the richest hay was made from grass cut early, it was not until 1926 that special attention was given to the idea of artificially drying short, young grass. In that year the late *Professor T. B. Wood* and *Dr. H. E. Woodman*, through their pioneering work at Cambridge, laid the foundation for the now comparatively familiar process of drying artificially grass for storage, so as to provide a perfectly balanced summer food at other seasons for all species of farm stock. The resultant product is a natural food containing highly digestible carbohydrates, protein, vitamins, carotene and minerals.

Pioneer helped by I.C.I.

Practically every innovation in farming is made possible by mechanization, or alternatively the innovation demands the introduction of the machinery for the purpose; in deference to that dictum, the pioneers of 1926 had to start from scratch. Fortunately Imperial Chemical Industries Ltd. were out to help research, as always, and, in 1927, in response to a request by Professor Wood, they made five tons of dried young grass.

Since that time dehydration has been applied to a wonderful range of products by artificial means and far beyond the dreams of those who in the past depended upon sun drying. Grass-drying equipment has been developed into many different types, and numerous improvements have been introduced. Chiefly, however, they may be divided into three classifications: batch, or tray, driers; endless-belt conveyor driers; and rotary-drum driers.

Of these the batch-drier type (I.C.I. Mark 3 and Curtis-Hatherop) is the least expensive to construct, depending as it does on the simple principle of drying 18-in. deep layers of grass evenly spread in large trays. Reasonable continuity in operation is secured by constructing the machine as a two-pair, two-stage outfit, one pair of trays being used for the initial 12½-min. drying period, while the other pair are giving the finishing spell of 12½ minutes to another batch. When drying by this air (300° F.) is

completed in one pair of trays, the hot draught is switched to the other pair. Dampers are provided to control the air entering the furnace, and also a by-passed current of air, so that the temperature of the air reaching the moist grass can be regulated. Manual work is slightly in excess of that required by other makes of driers.

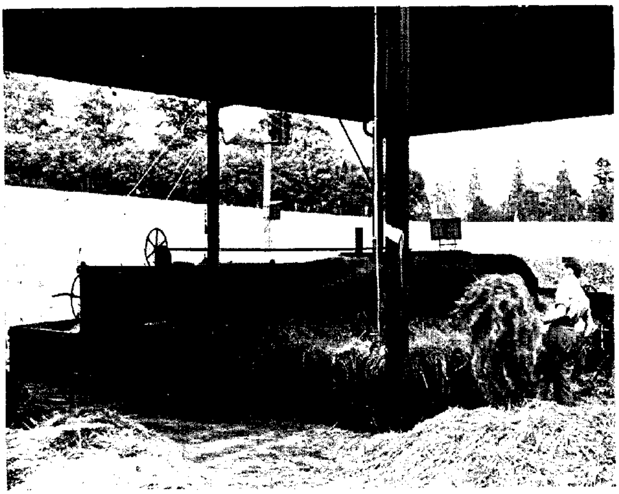

Fig. 4.30.—I.C.I. Mark 3 drier

Highly Mechanized Types.

More highly mechanized are the types with a drying chamber which is traversed by an endless-belt conveyor, such as is found on makes like those of Ransomes, Templewood or Petrie and McNaught driers. The cut grass is fed evenly on to the conveyor, which is of steel laths, or is of the wire-screen " apron " type. Power-driven, their speeds can be regulated by gearing. Fans blow or suck the hot air through the grass. To save site-space conveyors may be arranged one above the other, the drying material working its way from the top downwards, from one conveyor to the other. The agitation helps to prevent the grass from matting in spots of irregular degrees of dryness.

The other type of drier, while being labour-saving, incorporates a two-stage drying principle analogous to that featured in the batch type already noted. This is the rotary-drum style of drier,

of which there are several types in use. In one (Kaloroil) there are two hoppers into which the grass is dumped alternately. Below the hoppers is a rotary drum with spikes inside, which keep the grass from matting. The hot air ascends through the drum, where it finishes the drying of the grass. On passing through this drum upwards, the air enters the overhead hopper which is full of wet grass. The second hopper is being loaded. When the grass in the drum is dry, it is emptied out, and then down comes the now half-dried grass from the hopper, while the current of hot air is diverted to the newly filled hopper. The temperature favoured is 300° F.

America, as usual, is out for speed, and, with some machines, has been able to curtail the drying cycle to the incredibly short period of one minute. Naturally that involves the use of temperatures that call for machines adjusted to the split second, and most skilfully operated at that, to obviate scorching, or even burning, the product.

On page 91 of this book the attendant equipment for cutting the grass in the field and gathering it, is described (fig. 3.20).

Dried grass with moderate care can be stored in many different ways, but baling is the handiest, although that again adds a trifle to the equipment needs.

Features of a Good Drier.

A study of the various makes of drier on the British market will reveal that farmers have a wonderful range from which to select the particular kind to suit their requirements. The ideal drier may, or may not, exist, and, if it did, it would be expected to incorporate all the following features: reasonable initial and maintenance costs; low labour requirements; simplicity in operation; uniform quality of product; economy in power needs; and good efficiency—say 6½ to 7½ lb. water for every 1 lb. of coke used. The batch drier, noted at the outset, will remove 15 cwt. of water per hour from grass, leaving behind 4 cwt. of dried fodder ready for baling or storage.

Managing his grassland with that end in view, the farmer should aim at taking several cuts of grass in the season, although the farther north in Britain his farm is, the more difficulty he will have in doing so. His target should be a total yield for the season's cuts of approximately 50 to 60 cwt. of dried grass per acre. Three tons of dried grass give thrice the nutrient value per acre of oats, besides a much higher percentage return in digestible

protein and digestible fibre. Weight for weight, dried grass compares well with palm-kernel cake, cotton cake, and other concentrates. It is far ahead of silage in preserving the maximum of its original nutrients, and hay is not in the running at all. In addition, when used to feed milk cows, it has that valuable property of giving a rich tint to the colour of the cream, due to its carotene content.

CHAPTER V

Pest Control

The history of the development of scientific methods for the control of insect pests, fungal and virus diseases, and of weeds, is an excellent illustration of man's struggle for the control of his environment.

Agriculture itself is an interference with that state of equilibrium in nature, which has been termed the " balance of nature ". These pests and diseases have always been with us, but the further man swings the balance in one direction, the more difficult it is to maintain, and the more he must rely on his intelligence and knowledge to secure that biological control which is so essential for raising cultivated crops. References to various pests and diseases of crops were made in the oldest records of agriculture, but the potential threat of diseases to man's food supplies was first brought home forcibly to this country by the serious outbreak of " potato blight " in 1845 and 1846. Since then the war on pests of all kinds has grown steadily in intensity and, with increased knowledge, new products and fresh techniques have emerged to combat them.

It has often happened, however, that products which were capable of giving excellent control under laboratory conditions were of comparatively little value in the field, because the difficulties in the way of application were too great; and, as the efficiency of any product in the field is determined to a very large extent by the efficiency of the means of application, there has had to be alongside the development of new and better products, a parallel development of more efficient machinery and better methods of application.

The machinery required for pest-control purposes covers the application of weed killers, insecticides and fungicides, and the same spraying equipment is also used for the burning down of potato haulms and for the application of trace elements such as manganese to the foliage of growing crops. Products may be applied in the form of wet sprays, dry sprays (dusts) or gas.

Wet Sprays.

Wet sprays may be either in the form of a solution of the active ingredient or in the form of a suspension or emulsion. They have the great advantage that the diluent or carrier, if water, is cheap and normally freely available. Thus the cost of packing, handling and transport only falls on the concentrated material. Additional advantages are that an extremely uniform distribution can be effected in a very fine state of division, and under most conditions a wet spray adheres more firmly to the leaf surface than a dust.

The disadvantages are that with conventional sprayers about 100 gallons of water per acre are needed to give a good coverage, which means that a considerable amount of time and labour is involved in carting water and in pumping it into the container, even where mechanical self-filling devices are incorporated in the machine. Further, spraying machines must be of strong, sturdy construction, as the total weight of the outfit, plus water, means a fairly heavy draught and a machine which is not readily manœuvrable on steep land and in awkward situations, while the frequent filling required reduces appreciably the time spent on actual spraying.

These considerations were sufficiently weighty to warrant investigation of the question as to whether the volume of water applied per unit area could be reduced appreciably without loss in efficiency. The problem has been successfully solved by the development of "atomizer" sprayers using the carburettor principle of atomization, which reduces the amount of water required to about one-tenth of that used in conventional sprayers; and of "froth" sprayers which give a similar economy.

The essential points of a good spraying machine are:

1. It should give a uniform distribution of a fine mist-like spray. A coarse spray is undesirable as in this case there may be a considerable run-off of liquid from the leaf, which results in a wastage. Obviously the greater the proportion of the spray deposit retained on the leaf surface the greater the efficiency.
2. It should give the most uniform possible coverage of all foliage where this is essential, e.g. fungicide spraying of potatoes.

Dry Sprays or Dusts.

In dusts the active ingredient is incorporated in a very fine powder which acts as a diluent and carrier, the nature of the carrier being determined by the purpose for which it is to be used. For example, a rather heavier dust is used where either the soil or the top surface of low-growing plants has to be dusted, and a much lighter dust where a hanging cloud which will settle on all parts of the foliage and give the maximum cover is required. In some cases dusts have an advantage over wet sprays in that light dusts will drift into parts of the foliage which are difficult of access and which are liable to be missed by the direct jet of the wet spray. Again, dusts are delivered to the farm already prepared for use and require no further dilution or mixing. They are therefore very convenient in use, and with suitable machinery a large acreage can be covered in one day. On the other hand dusts are most susceptible to the vagaries of the weather as they require calm conditions at the time of application and, even when applied, are more liable to be washed off than wet sprays, once the latter have dried on the foliage.

Dusts are usually most satisfactory therefore where the action of the product is fairly rapid.

Gassing.

This method is less frequently used in this country on agricultural crops, possibly because the technique is rather more difficult and therefore more costly. It is accordingly used only where spraying or dusting do not give satisfactory results, and is in the main confined to market-garden crops. One such machine is described below under the heading of "Insect Control" (p. 164).

Aerosols.

A new technique, which has recently been evolved in this country, for the application of insecticides is by means of smokes or fogs, or "aerosols", as they have been called. By this method the insecticide is dispersed in extremely minute particles, which are airborne as smokes or fogs and only settle very slowly.

The method has been used in this country mainly for the destruction of pests in enclosed spaces, and proprietary "smokes" containing the new synthetic insecticides are now on the market; in America equipment is undergoing test for use on field crops.

This is a development of the equipment used by the U.S. Navy for the production of screening smokes, and it is hoped that it may prove useful, not only for the large-scale application of insecticides, but also for the application of fungicides and weed killers.

Machinery

Wet Sprayers.

These can be divided into three main types:

1. The standard wet sprayers, which apply anything from 60 to 120 gallons per acre.
2. " Compressor " sprayers which apply a similar quantity.
3. " Atomizer " sprayers which apply from 10 to 15 gallons per acre in a finely atomized spray.
4. " Froth " sprayers which emit a stream of small bubbles which disintegrate to produce a very fine mist.

1. Standard Type.—In the first two, dispersion is achieved by forcing the liquid through special jets under pressure. In the case of the standard sprayers this is effected by a pump located in the base of the sprayer, while in the compressor sprayer it is effected by compressed air. In this case, of course, an air-tight tank is required.

The standard wet sprayer consists of a barrel or container mounted on wheels, which may be steel or rubber-tyred, together with a pump driven off the wheels or by a small auxiliary engine. The pump forces the liquid to a spray bar mounted on the rear, and distribution is effected by forcing the liquid under pressure through specially designed jets. The spray bar is capable of adjustment in height to meet the needs of various crops. For spraying against weeds a standard horizontal spray-bar with jets disposed along it at appropriate intervals is used, but for fungicide spraying of potatoes special vertical multi-jet lances are used in order to give the maximum foliage cover.

There is a wide range of these machines from the simple manually operated barrel-type to the horse- or tractor-drawn models, with or without an auxiliary engine. Some of these are constructed of acid-resisting metals which render them suitable for spraying dilute sulphuric acid or other corrosive materials, but machines designed for fungicide spraying only are not usually so fitted.

A typical example of wet sprayer is illustrated in fig. 5.1. This machine, which is designed to be drawn by one horse and is suitable for spraying corrosive materials such as dilute sulphuric acid, has a barrel which will hold 100 gallons. It is preferable to mix the solution before putting it into the barrel, but there is a stirrer or agitator fitted so that the machine is capable of spraying Bordeaux or Burgundy mixtures, the ingredients of which are not soluble. The liquid to be sprayed passes from the barrel into a force pump driven from the land wheels of the machine, and from thence to

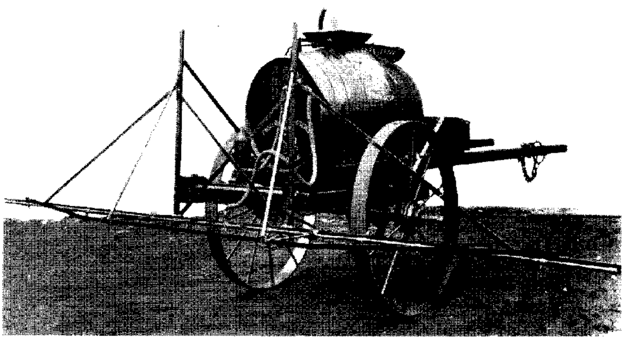

Fig. 5.1.—Horse-drawn spraying machine
(Barclay, Ross & Hutchison, Ltd.)

the spray bar, being forced through specially designed jets. The machine is illustrated with a flat spray-bar for either weed killing or for killing potato haulms. Special sprays for use with anti-blight mixtures for potatoes can also be fitted.

2. Compressor Type.—The " compressor " type of sprayer operates in much the same way, but the barrel or container is of stronger construction and is capable of being air-sealed when closed. The pressure on the liquid is exerted by compressed air within the container, compression being effected by power from an auxiliary engine or by a drive from the wheels. Safety valves are incorporated to blow off at a predetermined internal pressure. This is usually an all-purpose machine, the metals used being acid-resisting.

A compressor type of sprayer is illustrated in fig. 5.2. This is an all-purpose machine. The small air compressor is driven

by chain from the land wheels of the machine. Two safety valves are fitted, the pressure being maintained between 25 and 26 lb. per square inch. The machine is shown fitted with a flat spray-bar for weed killing or potato haulms, but special potato-blight fittings can also be provided. This machine is intended solely for tractor draught, and the machine is fitted with a filling pump which can be coupled up to the power take-off of the tractor. The use of this large-capacity pump, using a $2\frac{1}{2}$-in. pump hose, greatly lessens the time required for filling, and increases the net working time of the machine.

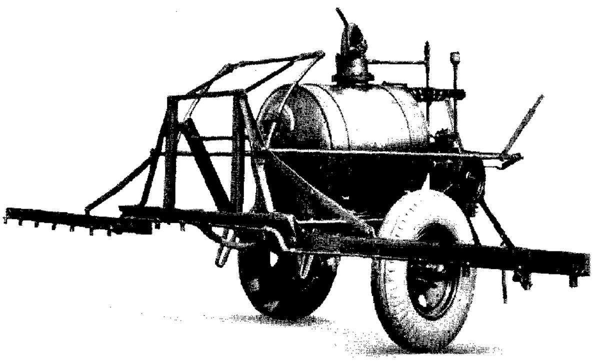

Fig. 5.2.—Compressor spraying machine
(*Barclay, Ross & Hutchison, Ltd.*)

3. Atomizer Type.—The "atomizer" type of sprayer is completely different in design, as in this case the liquid is fed at low pressure to the jets, and "atomization" is effected by the impact of a high-velocity current of air against the flow of the liquid from the jet. The advantages claimed for this type of sprayer are that only one-tenth of the water normally used is required; that there is a greater retention of spray chemical per unit area of foliage (by elimination of run-off); that there is a more uniform distribution of spray chemical over the foliage; that there is a quicker drying of the spray deposited; and that there is a higher proportion of effective spraying time as compared with conventional machines.

Fig. 5.3 shows an atomizing type of sprayer fitted with thirteen

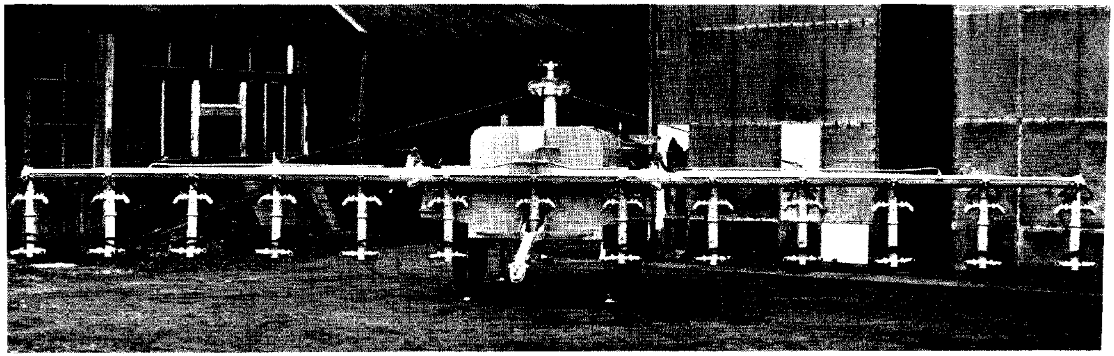

Fig. 5.3.—13-row "Agro" Automizer sprayer
(*Ransomes*)

pendants for spraying thirteen rows of potatoes (against blight). This machine, which is drawn by a tractor, has fitted as part of its equipment a 20-h.p. water-cooled petrol engine; this is coupled by means of vee belts to a centrifugal fan which provides the air supply to assist atomization. The engine also drives a centrifugal-type liquor pump. This pump delivers to a control valve a small quantity of liquid at low pressure and returns the balance to the liquor tank at a high velocity. The capacity of the liquor tank is 100 gallons and, as the machine is designed to use only 10 gallons per acre of highly concentrated mixtures, the time lost in filling is very greatly reduced. The fact that the machine is provided with its own engine enables a hydraulic lifting device to be incorporated for lifting the two outer sections of the boom when the machine is travelling, turning at headlands or passing through gateways. This machine is not suitable for use with corrosive sprays, such as sulphuric acid, as it is not made of acid-resisting material.

Additional equipment is usually required with wet sprayers unless such equipment is fitted as an integral part of the machine. For example, the pump which may be mounted on the machine is a serviceable adjunct in the filling of the spray barrel with the liquid. Where water is available in proximity to fields to be sprayed, an additional pump with a suitable length of hose is extremely useful in filling the barrels in which mixing is effected, or even in filling the water cart, where otherwise water would have to be carted long distances.

4. Froth Type.—" Froth " sprayers are a development of atomizer sprayers. The liquid has dissolved in it a frothing agent, and, on its way from the tank to the spray nozzles, it passes through a " frother " where it is mixed with air from a compressor. The froth is piped to the nozzles, whence it is blown out by a further blast of compressed air. The bubbles disintegrate on leaving the nozzles, and give rise to a very fine spray of uniformly sized particles.

Dusters.

As indicated earlier, dusting has certain advantages under particular circumstances, and the greater rapidity with which applications can be made, together with the reduction in labour involved, makes a definite appeal, particularly in districts where large areas have to be covered in a short time and where water is in short supply.

Dusting machines are fairly light and simple in construction,

consisting of a hopper to hold the dust, together with a fan or blower which forces the dust along a hollow boom and thence through a number of specially designed nozzles. In addition there is a feed-regulating mechanism and an agitator. These power dusters are usually tractor-drawn, and the blower drive is either taken by power take-off or by a small auxiliary engine. These outfits are mainly used for the fungicide dusting of potato crops or for the application of insecticides. In the case of fungicide dusting, as it is extremely important that the maximum amount of dust should be retained on the leaf, it is most efficiently carried out when the foliage is covered with dew.

Weed Destruction.

The damage and loss caused by weeds has been a constant source of worry and trouble to everyone associated with the land since ever land was cultivated. The loss of yield due to weeds alone in this country must run into tens of millions of pounds annually, while much labour is involved in the wearisome business of killing weeds. In cereal crops yields have been raised as much as 90 per cent by the total and early elimination of a heavy weed infestation.

The technique of horse-hoeing grain crops in bygone days was a device to kill weeds rather than to cultivate the soil, while to-day most of the inter-crop cultivations are directed towards the same end.

With the rising cost of labour the control of weeds becomes more important than ever. In cereal crops, chemical methods for the control of weeds have been in use for many years, and in recent times some remarkable progress has been made as the result of intensified efforts to discover more efficient and more selective weed killers. Of weeds in cereals, charlock is perhaps the most destructive, and in the past the most popular weed killer was *copper sulphate* at from 2 to 4 per cent in 80–100 gallons of water per acre, to which *sulphate of ammonia* was sometimes added at 5–10 per cent. Under dry, sunny conditions a good kill could be obtained, but under adverse conditions the results could be disappointing. More recently a solution of *copper sulphate* (2–3 per cent), *plus salt* (2 per cent), has proved even more effective, but is inclined to scorch the cereal foliage, while it is very corrosive to metals.

In 1932, the practice of spraying with *dilute sulphuric acid* was

danger that a drifting cloud of spray or dust may cause serious damage to neighbouring crops.

In the field of non-selective weed killing, *sodium chlorate* has been used effectively to kill weeds such as couch grass and thistles at rates of from 1½ to 2 cwt. per acre. It should be applied to give a minimum period of six months (or longer, under very dry conditions) between application and the sowing or planting of the next crop. It has also been used effectively as a selective weed killer against annual nettles in catch crops of Italian ryegrass as a wet spray at the rate of 8–10 lb. per acre suitably diluted.

Fungicide Spraying of Potatoes.

The fungal disease popularly known as " blight " is the most widespread and destructive disease of the potato crop. As the growth and development of blight is dependent on humid conditions, its incidence varies from season to season and from district to district, and it is this seasonal variation in incidence which makes it difficult for farmers in some areas to make up their minds as to whether they should make spraying against blight an annual routine spraying or not. In other districts, as for example in Ireland, regular routine spraying is clearly an economic necessity. A serious attack of blight can destroy the foliage very quickly, with consequent loss of yield. If the attack is early and heavy, the loss in yield may be disastrous, while the later the date of the attack, the less is yield affected. In addition to the loss in yield, there is also a loss on account of diseased, unsaleable tubers.

Estimates of losses are virtually meaningless on account of the wide variations which may occur, and these may vary from nil to six or more tons per acre. There is no doubt, however, even where there is only a moderate attack, that it will pay to spray with fungicides. Losses at the time of lifting may not be the end, as tubers which are perfectly sound at lifting, may become infected by spores from the foliage or the soil, with consequent serious losses in the pit.

When blight attacks the foliage late in the season, this " pit blight " is the greatest source of loss, and may be extremely serious. In addition, pit blight adds very greatly to the labour of dressing. Copper compounds have so far proved to be the most useful in the control of blight, and Bordeaux and Burgundy mixtures are common examples.

More recently, proprietary products based on cuprous oxide

and copper oxychloride have been marketed. These have the advantage that they are extremely convenient in use, merely requiring the addition of the powder to the requisite quantity of water. Copper fungicides may be had also in dust form, but dusting is less efficient than wet spraying and has to be carried out more frequently to achieve a similar degree of control. For optimum results dusts should be applied when the foliage is wet with dew.

The most important consideration to bear in mind is that anti-blight spraying is essentially preventive and not curative. Accordingly, the first spraying should be carried out before blight appears, as, if an attack develops, it can spread very rapidly, and once it gets a firm hold control is difficult if not impossible. Waiting for blight weather often means that broken weather and wet soil conditions make spraying impossible. The date at which spraying should commence will depend on climatic conditions and the locality. In the South of England, blight may be expected to appear any time after the beginning of June, and further north from the end of June onwards. The number of sprayings will depend on the weather. In a very dry season one spraying may suffice, but normally at least three sprayings will be required, at intervals of about three weeks.

Burning-off of Potato Haulms.

The burning-off of potato haulms is a practice which has increased greatly in popularity in recent years, particularly in seed-growing districts, and it serves a triple purpose: (1) to check growth at the stage when the maximum yield of seed size tubers may be expected; (2) to kill off all the disease spores on the foliage to minimize infection of sound tubers at lifting; and (3) to eliminate the haulms and as many weeds as possible which interfere with the process of lifting. This is particularly important with the newer types of potato diggers and harvesters, where haulms, weeds and clods tend to clog elevators. Burning-off eliminates very largely the losses due to infection of tubers by spores from the foliage at the time of lifting, and, where shaws are not withered down, losses from blight developing in the pit may be very high. Paradoxically enough, it is even more essential to burn-off potato haulms where fungicide spraying has been carried out, as this tends to keep the foliage green for 2–3 weeks longer than when spraying has not been carried out. Even a small proportion of infected foliage can infect a high proportion of the exposed tubers.

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The sprays most commonly used for burning-off are: **sulphuric acid** (13–15 per cent), **copper sulphate** (3 per cent), **copper sulphate** (3 per cent) plus **common salt** (1–2 per cent), **sodium chlorate** (1·5 per cent), **tar-distillate** washes (8–10 per cent), all at 100 gallons per acre.

Of these, sulphuric acid is the most efficient, though some of the newer tar-distillate washes are showing considerable promise. They have the advantage, which they share with sodium chlorate, that they are non-corrosive to metals.

To ensure that most of the spores in the ground as well as on the plant are dead, lifting should be delayed for at least some days and preferably fourteen days after spraying.

Insect Control

While the damage caused to agricultural crops by insect pests in this country every year is very considerable, control by means of insecticides has only been practised in the past on a rather limited scale. This was not due to any lack of awareness of the damage, but in the main to the lack of practical and economic means of control. Losses caused by insects may be by direct effect on yield and indirectly as carriers of virus diseases.

In the past few years two new insecticides of very high potency, "**Gammexane**" and "**D.D.T.**", have emerged which may provide the answer to some at least of the problems of insect control. These have already proved their worth, as, for example, in the control of locusts abroad, and in the control of the turnip flea beetle and wireworm in this country. A considerable amount of research work has yet to be done, however, before the economic value of these new products can be fully assessed.

Wet spraying against agricultural pests is not common, but an appreciable amount was carried out during the war years with **arsenicals** against the dreaded Colorado beetle. Perhaps the commonest use of an insecticide on the farm is in the control of the turnip flea beetle. Before the war proprietary products based on **derris** were used, but these have been replaced by even more efficient products based on "Gammexane" and "D.D.T.". These are supplied in the form of dusts and applied broadcast by means of a fertilizer distributor, or through a turnip barrow to sow a 4-in. to 6-in. strip along the rows of plants, or by a power duster.

These should be applied when the beetle is active, that is, in dry sunny weather. Heavy rain may necessitate a further application.

Early application is essential, as the flea beetle may attack the seedlings before they have fully emerged, and even if the attack is delayed until after emergence, the draining of the sap from the

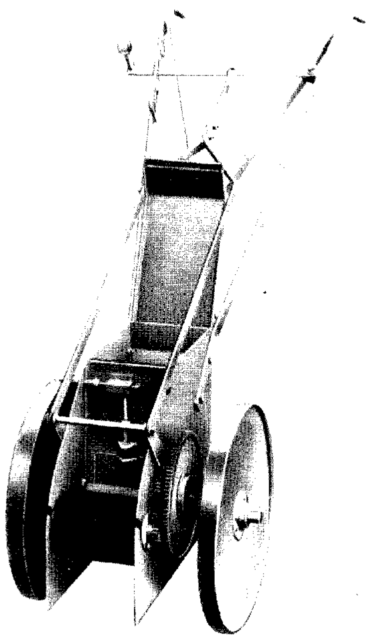

Fig. 5.4.—Flea beetle dusting machine
(Ransomes)

punctured leaves prevents the seedlings from making anything but slow growth. Aphides on brassicæ and sugar beet frequently cause serious damage, and efficient control is difficult to achieve.

Fig. 5.4 shows a machine for the application of flea beetle dust to turnip crops. The machine, apart from wheels and carriage, consists of an endless band working along the bottom of a hopper in which the dust is contained. A regulated quantity of the dust is

carried off along the band, being afterwards brushed off it by a brush on to the plants.

The application of **nicotine** dusts gives useful control when conditions are calm and warm, but an even more efficient control is effected by using vaporized nicotine. A special gassing machine is required for this purpose which consists of a vaporizing chamber, metering device and ducting which leads the hot gas to the crop to be treated. Behind the machine is drawn a light impervious sheet about 100 ft. long, which confines the gas sufficiently long to kill the aphides. The outfit is tractor-drawn through the crop at a speed of one mile an hour, which gives the plants and their insect enemies a period of exposure to the nicotine gas of about one minute. This machine is mainly used on market-garden crops and on sugar beet.

Wireworms can do serious damage to cereal, potato and brassica crops. There is now evidence that products based on the new insecticide Gammexane can give effective control. These are either applied broadcast by fertilizer distributor on the plough furrow and harrowed in at the rate of 2 cwt. per acre, or drilled in with the seed by means of the combined seed and fertilizer drill at half this rate.

Another pest which can do considerable damage to cereal crops is the " leather jacket " or grub of the cranefly. The recommended treatment is **Paris Green** applied at the rate of 1-2 lb. per acre in 40 lb. of bran moistened with dilute molasses. Paris Green is an arsenical poison and must be treated with due care. Leather jackets may also cause serious damage to swards directly reseeded from old grass, and in this case dusts based on Gammexane or D.D.T. give effective control. These should be applied in September when the young larvæ are in their immature and least-resistant stage.

Cereal Seed Disinfection

Long before there had been any approach to the scientific study of fungus diseases, farmers had come to connect certain diseases of cereals with something inherent in the seed. Remedies such as steeping the seeds in a solution of salt and lime, and later in steeps of copper sulphate or formaldehyde were employed. Water treatments were objectionable in many ways and the discovery of highly efficient fungicides of the *organo-mercurial type*, which could be

applied incorporated in a fine powder, was a great advance and gave a big impetus to the disinfection of cereal seeds; this has now become accepted routine practice on most farms.

This discovery also gave a stimulus to further research into the incidence of seed- and soil-borne diseases which is still proceeding.

By means of the organo-mercurial dusts, excellent control can be obtained of the seed-borne disease " leaf-stripe " of oats and

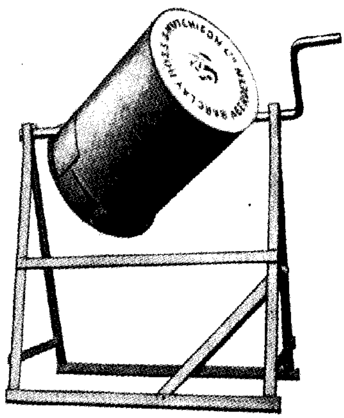

Fig. 5.5.—Farmers' type chemical dresser
(*Barclay, Ross & Hutchison, Ltd.*)

barley, " loose " and " covered smuts " of oats, " covered smut " of barley and " bunt " of wheat. In addition good control can be kept of mainly soil-borne disease, chiefly of fusarium species, which gives rise to " seedling blights " in root crops.

The machinery required for applying this seed dressing is fairly simple, and a wide variety has been used, ranging from the home-made batch dressers of the end-over-end churn type and the small continuous dresser driven by either hand or power, up to the large power models suitable for big-scale operations with a throughput of 2 to 3 tons of grain per hour.

These power machines consist in essence of a feed hopper and

mixing chamber, with a metered feed device to ensure positive and accurate feeding of the mercurial powder in relation to the rate of flow of the grain as a continuous process. The usual bagging-off arrangements are fitted. In some machines a knock-out device is fitted which makes it impossible for any grain to pass through

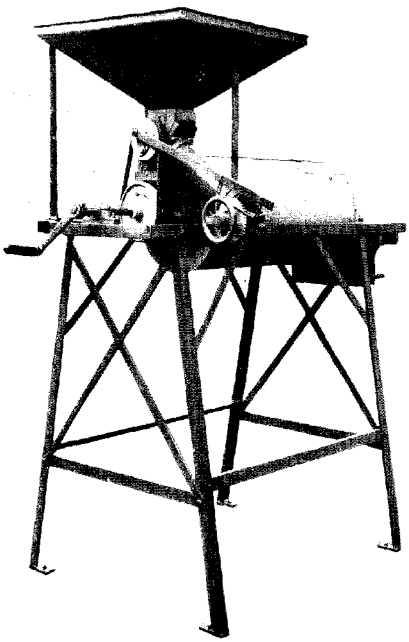

Fig. 5.6.—" SAI " chemical dresser
(Barclay, Ross & Hutchison, Ltd.)

if the supply of seed dressing runs out. The powder feed can also be adjusted to various rates of dressing. The elimination of dust in any large-scale work is an important feature.

Fig. 5.5. shows a small end-over-end churn type of dresser which is designed to do one bushel of grain per batch. Probably the most widely used machine is that shown in fig. 5.6, which is a continuous dresser capable of being worked by hand, but also adapted for power. This machine has an output of 48 bushels

per hour; it will dress at any one of four rates, namely $1\frac{1}{2}$, 2, $2\frac{1}{2}$ and 3 oz. per bushel; the feed of grain and powder are synchronized and the grain stops immediately the supply of powder is finished. There are several other machines on the market of larger capacity than those cited above but, as these hardly come into the category of farmers' machines (they are usually to be found in granaries and seed warehouses), they are not illustrated.

It may be of interest to record that, in Scotland, Messrs.

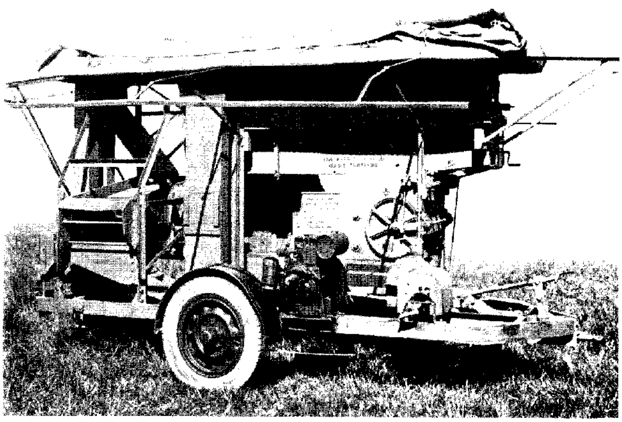

Fig. 5.7.—Mobile chemical dresser
(*Barclay, Ross & Hutchison, Ltd.*)

Scottish Agricultural Industries, Limited, have had for some years a number of machines known as " mobile sizers and dressers ", and their service covers more or less the whole grain-growing part of Scotland. These machines, as shown in fig. 5.7, are self-contained; are arranged to be drawn behind a motor vehicle; and travel from farm to farm sizing or screening the farmers' own seed grain and dressing it with powder. Such a machine is of particular value in those areas where the threshing is mostly done by a single-dressing thresher having no rotary screen.

CHAPTER VI

Dairy Machinery

Milking Machines

The Evolution of the Milking Machine.—As with most mechanical innovations, the early contrivances intended to milk cows and do away with hand milking were extremely and almost unbelievably crude. About the time the Rev. Patrick Bell invented his reaping machine (1827), the first attempts were being made to produce a mechanical milker. But the milking-machine idea did not

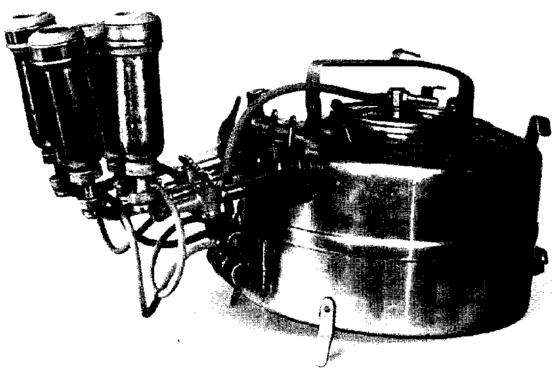

Fig. 6.1.—One of the earliest milking machines
(*Alfa-Laval Co. Ltd., Brentford*)

arouse the same enthusiasm as did the reaper, and it was more or less shelved for a time. One early method involved the insertion of straws into the cow's teats to drain the milk from the udder; but this plan did not survive, as one might expect, and metallic tubes later were employed with flexible tubes attached to them to drain the milk into the pail. Simple as that idea was, no less than six patents were taken out covering variations in its design.

The late Robert Wallace of Castle-Douglas—an honoured name in milking-machine matters—said that these contrivances were offered for sale at the Ayrshire Agricultural Association Show in the early seventies, and for a time were used by some farmers. Their unsuitability for continuous use soon became apparent, owing to the difficulty in keeping sterile the parts which were inserted into the udder.

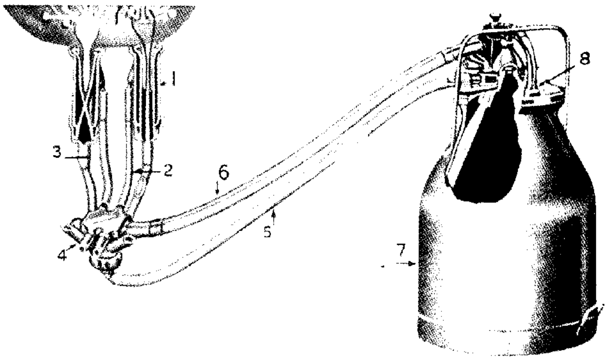

Fig. 6.2.—Alfa-Laval pulsator unit

1. Teat cup; 2. Short pulse tube; 3. Short milk tube; 4. Milk claw; 5. Long milk tube; 6. Twin pulse tube; 7. Milk pail (stainless steel and tinned steel); 8. Operating cover.

Teat-pressing Machines.—Moreover, it was obvious that these forms of milking equipment lacked some of the merits of even hand milking, and designers soon got busy to plan something that would simulate the action and effect of hand milking. A variety of contrivances were produced and they were broadly grouped under the *pressure* principle, later being superseded by machines applying *pulsating suction* to the teats. Among the pressure media employed were plates caused to approach and recede by a system of levers; rollers running down the teats while pressing them against a fixed surface; fluid pressure made to actuate a succession of pistons tipped with rubber, arranged that a descending squeeze was effected; and pressure by compressed air made to inflate annular bags of flexible material which surrounded the teats. These were some of the main ideas, which, with many others, were employed to imitate hand milking.

Machines to suck the Cow.—If the early attempts to devise milking equipment had been rough-and-ready, there was nothing cheap or crude in the policy of latter-day makers, and one world-famed firm produced about a score of different models in as many years. The great majority of these were not marketed because the firm, while its machines were as good as any on the market, did not feel it was advisable to put them on sale. But the suction principle was gradually introduced and developed by dint of much expenditure by well-known makers.

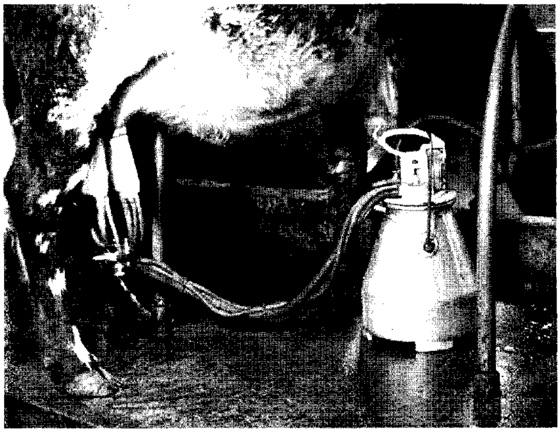

Fig. 6.3.—Bucket plant (*Gascoignes (Reading) Ltd.*)

Pulsating suction is produced by vacuum pump actuated by electric motor, or small engine, and is transmitted by pipe line to the teat contacts. A later development utilizes magnetic instead of pneumatic force; it has the advantage of simplicity in construction and calls for less power.

Within comparatively recent years many refinements have been added to milking machines in the way of adapting them to the most modern ideas in the design of dairy-farm premises, in subscribing to up-to-date hygienic demands, and in recording the individual milk yields of the cows.

Revolutionized the Dairy Industry.—In the eyes of people with experience of a couple of decades ago, we have not a supply of cheap milk, and on first thoughts it might be remarked that

the mechanization of the operation of milking the cow has not paid its way, so far as consumers are concerned. That, however, is not the true position. It must be remembered that hand milkers, male or female, are no longer available in sufficient numbers, because farm hands shun this kind of work. So few will have anything to do with it that, had there been no milking machines, there would be only so many cows to-day as there are hand milkers willing to milk them. Thus the cows would be so few as to create

Fig. 6.4.—Auto-Recorder milking plant (*Gascoignes*)

a milk famine, and what there would be of it would sell at famine prices. The milking machine has not only revolutionized dairy farming, but has made it possible in these days of labour troubles of various kinds. Milking machines used in the larger herds have shown an appreciable cut in the costs compared to hand milking, but, as indicated above, that is not their main recommendation, which is that they have made dairy farming possible at a time when there was every evidence that the supply of hand milkers was to be far short of national requirements.

In that respect it has solved the problem that was going to mean the doom of the production of milk for consumers. So much

has it appeared to simplify things for the dairy farmer that many people inexperienced in milk production have rushed into that line of business attracted by the " push-button " prospects and the ready-money character of the enterprise. The milking machine, however, is no substitute for a thorough knowledge of dairy-farming technique generally. The human element is paramount

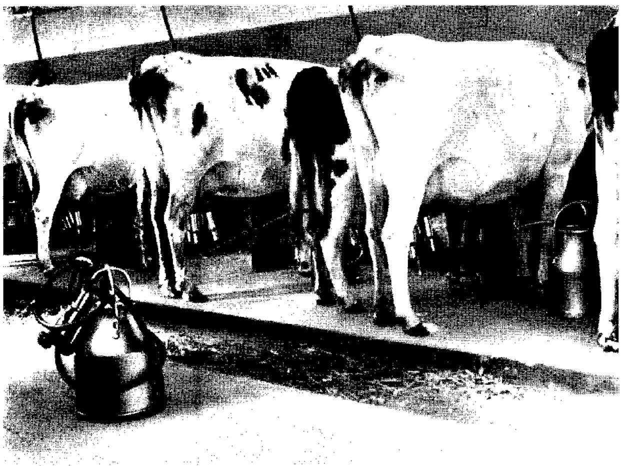

Fig. 6.5.—Milking machine
(J. & R. Wallace, Castle-Douglas)

all the time, and even the success of the work of the milking machine itself depends in the end upon whether or not the operators manage it with intelligence.

Cleanliness is a First Essential.—Of all food products, milk is the most easily contaminated, and it may, and often does, undergo serious deterioration in the handling after the milking machine has served its purpose to perfection. It is that piece of equipment, however, with which we are concerned here, and its specific demands in the way of management are not too difficult to live up to if there is a good supply of pure water. The first essential is cleanliness, the second is the same, and the third is ditto. The war against dirt must be conducted all the time, systematically, by soaking of parts, washing them inside and outside, using warm cleaning solutions and boiling water where required. Otherwise mechanical

milking can be a source of grave trouble to operators, producers, consumers, and sanitary and health officials, and it would also fail to fulfil one of the most important services it can render—the provision of a cleaner method of taking the milk from the cow than by hand.

Steadily, of recent years, reliance on machine milking has extended until the manufacture and sale of such equipment have become enterprises of vast magnitude, the early prejudices of dairy farmers having been completely broken down. These installations are found everywhere, and even in supposedly remote and backward districts. Most large herds are milked by them and countless small herds as well. The following is a list of some of the makes used in Britain: Alfa-Laval Co. Ltd., Brentford; "Manus", R. J. Fullwood & Bland, Ltd., Ellesmere, Shropshire; Gascoignes (Reading), Ltd., Reading; Simplex Dairy Equipment, Ltd., Cambridge; Vaccar, Ltd., Stanpit, Christchurch; J. and R. Wallace, Castle-Douglas.

The Wonderful Cream Separator

As already noted, the disregard for labour-saving innovations was specially noticeable in the dairy industry, yet to-day very few farmers who make butter would like to be without a *cream separator.* The invention of it by *de Laval* was truly a wonderful achievement, for, as the word implies, it separates the cream from the skimmed milk, and does so while the milk is still warm. Not only does it separate it, but it assures the user of approximately 20 per cent cream above the hand-skimming process. Anyone who has examined the bowl of a cream separator after separating will find an accumulation of slime and sometimes even clots of blood which would otherwise have been left in the milk for human consumption. For the sake of cleanliness alone, every butter maker would be advised to use a cream separator (fig. 6.6).

At one time there were many arguments against the use of the cream separator—the butter would not keep after it; the calves would not thrive on the skimmed milk; but the best one was the Dumfriesshire farm servant's advice to his friend: "Don't go to that farm next year, for they thresh the milk there." It has been proved beyond doubt that butter made from separator cream keeps longer than that made from hand-skimmed cream, and calves do

thrive on skimmed milk if it is supplemented with additional balancing foods. With careful use a separator should last upwards of twenty years, and some have been known to last thirty years.

As with all dairy utensils, the separator should be kept scrupulously clean. It should be washed night and morning in hot water and allowed to dry before assembling. A cream separator should

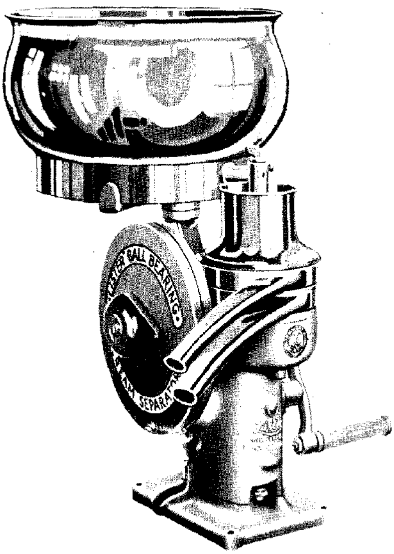

Fig. 6.6.—Cream separator
(*Lister*)

be turned at the speed advised by its maker, no faster or slower, in order to yield the maximum percentage of cream. The reason for this is because the act of separating the cream from the milk is caused by centrifugal action. The heavier substance, the skimmed milk, is automatically thrown towards the outside of the bowl plates revolving at up to 7000 r.p.m., while the lighter and more valuable substance, the cream, is forced up the centre core of the bowl. Too high a speed would cause some of the cream to be thrown down the skimmed-milk spouts; whereas too low a speed would have the reverse effect. The bigger the capacity of the separator

the slower the turning speed, because the bigger the bowl in diameter, the greater its peripheral speed.

Clean Milk.—There is a vast difference between the milk of to-day and that of thirty years ago. Thanks to the Ministry of Health it is now an offence to sell milk deficient in fats or tainted in any way. The bases of clean milk are:

1. The healthy cow; a cow that is free from any tubercular disease.
2. The clean byre and one that is not only well ventilated but well lit.
3. The clean cow, which should be properly groomed, and the udder washed, daily. No cow can be considered groomed unless the rear part and the udder hair are clipped.

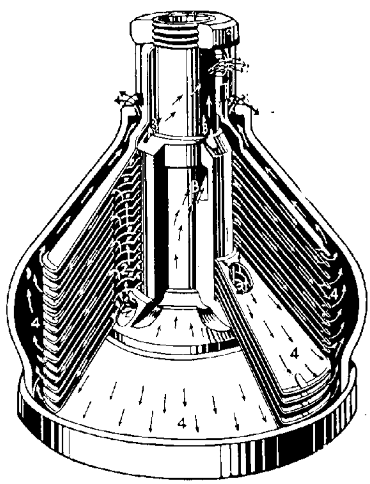

Fig. 6.7.—Cross-section of Alfa-Laval cream separator bowl

Milk Cooling

Many years ago farmers learned that both milk and butter kept better in a cool place. Good ventilation for the dairy is absolutely essential with, where possible, a shady exposure or a northerly aspect. As the practice of selling milk to remote consumers developed, means had to be devised to keep it sweet on its journey

from farm to consumer. At first milk churns were immersed every night in a cold well, or placed under a water spout; even to this day many farmers find this an effective way of cooling their milk, but a *cooler* (fig. 6.8) is more generally used.

Cooler.—The cooler is made of two corrugated sheets of tinned copper with just enough space inside for the cold water to flow upwards. Milk, fresh from the cow, is emptied into an 8- or 12-gallon receiving tin which is fitted with a tap. When the tap is

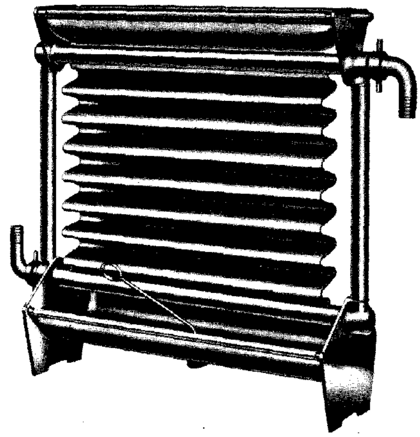

Fig. 6.8.—High-pressure tubular milk cooler
(Wolseley Sheep-shearing Machine Co., Ltd., Birmingham)

opened, the milk flows into the top trough of the cooler, which distributes it evenly along the whole outer surface of the utensil, down which it flows. The milk, having passed over the last corrugation, is collected in the bottom trough; this has an outlet plug which allows the milk to flow into the milk churn. The cold water enters at the lower end and rises between the thin sheets to leave at the top end of the cooler. In its passage the cold water absorbs heat from the downward-flowing milk.

Tinned copper sheets are used in the building of the cooler since copper is a good conductor of heat and is corrosion-resistant. These tinned sheets are necessarily very thin so as to conduct heat more readily from the milk to the cold water.

The popular capacity of a milk cooler is about 80 g.p.h. and it measures 18 in. wide by 20 in. deep. As herds tend to increase in size the demand for a cooler of, say, 125 and even up to 175 g.p.h. is evident.

In the more modern byres the milk is not carried into the cooler house, but is poured into a receiving vessel in the byre and passes through a pipe to the cooler.

It is now argued that water coolers, such as that just described, do not reduce the temperature of the milk sufficiently, and there is an increasing demand for *mechanical refrigerators* which ensure a milk temperature of 40° F. Unfortunately a refrigerating plant is expensive.

Plant for Sterilizing

Despite recurring allegations that the general cleanliness of milk is unsatisfactory, it is still a fact that milk producers and milk handlers can give points to those engaged in all other branches of the food industry. This applies with particular force to the process of sterilizing containers and utensils of various kinds. Indeed *public health* will never be what it ought to be until caterers generally take a leaf out of the book of the dairy farmers and sterilize every plate, cup, spoon and knife with steam, as is done with milk bottles, &c., on the farm or in the central distributive depots. What happens to milk in containers which have not been sterilized, is just what happens to foods generally when placed in receptacles which have not been through a steam chest at the proper temperature of 210° F. for at least 10 minutes.

If milk is to be wholesome and is to keep fresh for a reasonable time, all utensils must be clean and sterile. After thorough washing, everything intended to hold milk, or come in contact with it, must be sterilized. Such milk containers include milking machines, coolers, churns, bottles, &c.

Of sterilizing equipment for the dairy farmer there are several makes, all designed to steam-sterilize milk containers quickly, efficiently and economically. The primary section is a boiler made to take the required steam pressure with an ample safety margin; the heat for steam raising is mostly derived from coal, although the boiler may be adapted for other forms of heating. Chief merits to be looked for in boilers are fuel economy and speed in getting up steam. From the boiler the steam enters the sterilizing chest,

which is constructed of steel and wood, and is fitted with racks and a thermometer. After the utensils are placed on the racks the door is shut and the steam is turned on.

Development of Modern Equipment.—The evolution of sterilizing appliances is well illustrated by the stages in the development of outfits produced by Barford & Perkins, now Barford (Agricultural) Limited, Grantham.

Their dairy equipment first came into being in 1923, when, at the suggestion of Dr. Stenhouse Williams, who was founder of the National Institute for Research in Dairying, Reading, it was realized that milk, being an extensive germ carrier, required certain treatment, which was also necessary for the utensils carrying it.

With this in view, the firm set about designing a sterilizer which would be capable of fulfilling these requirements. Various attempts were made to achieve this end and much assistance was given by the National Institute for Research in Dairying, Reading. Eventually there was placed on the market a sterilizing outfit, known as the Barford & Perkins Clean Milk Outfit. This consisted of a low-pressure boiler working at $1\frac{1}{2}$ lb. per square inch, from which some 20 gallons of hot water could be drawn for washing purposes. The container, or sterilizing chest, was of 48 c. ft. capacity. Steam inlet and outlet connexions were provided, together with a suitable thermometer.

In these early days it was impossible to find really interested farmers who would install this equipment at their own expense, but a certain amount of assistance was given when the Government Milk and Dairies Order of 1926 was brought into being, and the sale of this type of sterilizing equipment then increased rapidly. In fact, it was found that there was quite a demand for an outfit of greater capacity, to deal with utensils for a larger herd.

The next size of outfit, known as the " Pioneer ", was then placed on the market. This was similar in construction to the Clean Milk model, but the boiler had a working pressure of 5 lb. per square inch, and was fitted with an automatic water feed capable of maintaining the water at a constant level. A slightly larger sterilizing chest was also provided, having a capacity of 75 c. ft.

Stepping-up the Pressure.—Later experience showed that even the Barford boiler at 5 lb. pressure was insufficient to give perfect sterilization of the various milk utensils unless the boiler was fitted within a few feet of the sterilizer, which could not be achieved in every case. The " Wembley " boiler was then put on

the market, and this was produced by modifying the old Barford & Perkins Type A boiler. The latter had been supplied as far back as 1870 on farm cooking apparatus, and had a working pressure of 10 lb. per square inch. The Wembley boiler, although of similar design, was modified according to insurance companies' requirements, and built for a working pressure of 20 lb. per square inch. When it was placed on the market it was found to overcome a lot of the difficulties. However, as time went on, there was a call for still greater pressure. Certain modifications were again carried out to the Wembley boiler and insurance companies agreed to a working pressure of 30 lb. per square inch.

It must, however, be realized that up to this time farmers had installed the equipment at their own expense with a view to producing a good-quality milk for the public. It was not until 1934–5, however, that a hard-and-fast rule was brought out to the effect that all dairy utensils must be sterilized; after the formation of the Milk Marketing Board, the Government laid down a ruling, under the heading of "The Accredited Milk Scheme", which definitely stated that, in the first place, cows must pass veterinary inspections four times a year, and all utensils coming into contact with raw milk must be thoroughly steam-sterilized. This meant that during the year 1934–5, thousands of Barford steam sterilizing plants were installed on farms throughout the British Isles, and during 1936 the Ministry of Health were able to announce that the standard of the nation's milk supply was at that time exceptionally good, and considerable progress had been made in the reduction of tubercular cases.

Cross-tube Boilers Introduced.—The demand for more boilers went on, and eventually Barfords placed on the market, in 1936, a small, cross-tube boiler which was known as the "Invicta", 4 ft. by 2 ft., with a working pressure of 80 lb. per square inch, and an evaporation of 130 lb. of water per hour (fig. 6.9). It became exceptionally popular, because, with the high evaporation, it was found that sterilization could be carried out with the minimum delay.

Following this came the next size of cross-tube boiler, known as the "Invicta Major", with a working pressure of 80 lb. per square inch and an evaporation of up to 160 lb. of water per hour. This boiler was installed on farms where they required a large amount of steam and hot water, and where the herds to be milked were above the average in size.

Improving the Older Types.—About this time it was found that the old type "Safety First" boilers of the Pioneer model were either too large or had insufficient pressure to meet increased demands, and in 1936 Barfords produced what is known as the "Wizard" boiler, working at 15 lb. per square inch and with an evaporation of up to 60 lb. per hour. This boiler, with a standard 3 ft. by 3 ft. by 3 ft. (27 c. ft.) sterilizing chest, proved extremely popular. Thousands were turned out in the years which followed,

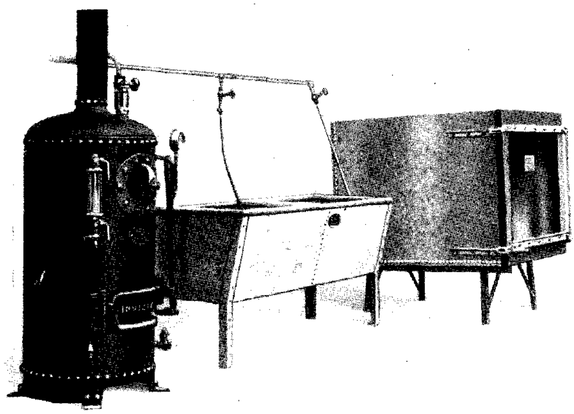

Fig. 6.9.—"Invicta" sterilizing outfit
(Barford (Agricultural) Ltd., Grantham)

and were supplied to the smaller dairy farms throughout the country. They sterilized thoroughly and also provided some 20 gallons of hot water for washing-up.

The Wembley boiler still remained in existence and is being made and sold in quantities to-day. This boiler is of the down-draught construction type and is most economical in fuel. It is easy to clean and, with its removable top, the interior can be kept in good condition, especially where the water is hard.

Sterilizers for N.A.A.F.I. Canteens.—Barford boilers found their way into N.A.A.F.I. canteens and Government hostels providing steam for heating water, washing crockery, utensils, &c., and also for work in connexion with cooking purposes. At one period during the war sterilizers were supplied fitted with suitable racks for the purpose of sterilizing cups and saucers in army

camps to prevent the spreading of disease—a policy that, sooner or later, will receive a wider acceptance in all communal eating places, if public health is really to be looked after.

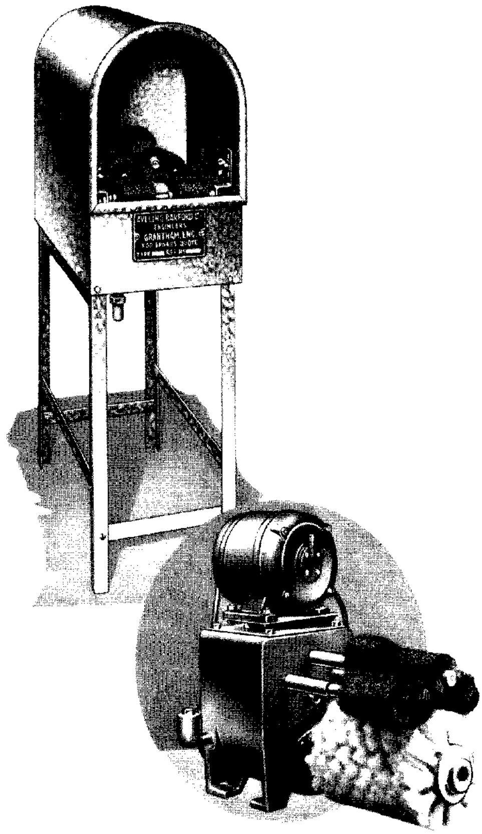

Fig. 6.10.—Electrically driven milk bottle washing machine
(Barford)

It will be seen that the drive and fight against tubercular and other germs is still going on after all these years. In 1943, for instance, Barford's output of sterilizing plant was trebled.

Electric Sterilizers.—In 1931 a certain amount of thought was being given to electrical equipment to be used on the dairy side, and Barford & Perkins produced the first *electrical sterilizer* to be placed on the British market. It was made in ranges, from

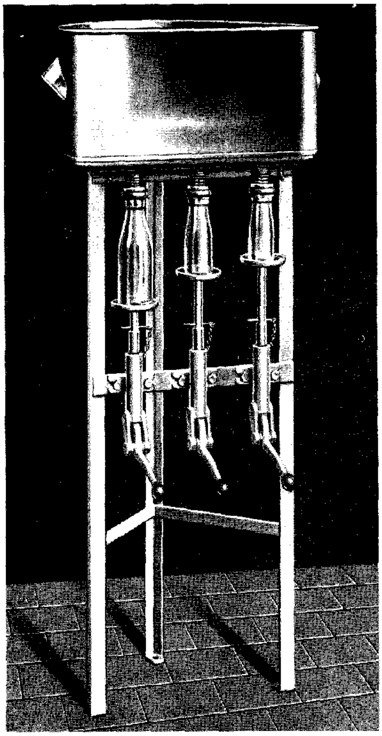

Fig. 6.11.—Three-valve bottle filling machine
(*Barford*)

27 to 75 c. ft., and had various loadings. It was found that these chests were not economical unless they were suitably " lagged ", and in those days they were " lagged " with plastic asbestos covered by galvanized sheet.

Pasteurizers.—Pasteurizers for the small farm were also brought into being in 1929, and were made in various ranges from

15 to 100 gallons, so that the small farmer could, if necessary, supply pasteurized milk to compete with the larger dairies.

Refrigeration.—Refrigeration on the dairy farm began to take shape round about 1930, and Barfords placed on the market the well-known "Ethylor" milk cooler, which was self-contained, with its own compressor, cooler, &c., and proved very popular until more modern methods were brought out at a later date.

Bottling Machines.

Some of the show pieces of the great milk-handling depots are the huge milk-bottling installations, capable of filling hygienically thousands of bottles every hour. These labour-, time- and money-saving outfits, in various sizes, are also used on countless up-to-date dairy farms. Mechanical bottle washers too are largely employed by milk producers and milk distributors, and, while some ingenuity was involved in designing them originally, they are simple enough in the principles upon which they operate—electrically driven revolving brushes and rinsing jets are applied to the bottles in large galvanized steel troughs (fig. 6.10). Only with such mechanical aids could the vast milk industry of to-day survive the labour shortage, and deliver milk on time.

CHAPTER VII

Care and Maintenance

After farmers have obtained what they consider to be the best and most economical implements and machinery to use on their farms, there are two vital points that many forget—namely, the care and the servicing of this machinery. It is astonishing to see on some farms machinery that has cost often £100, or more, standing in the field long after the finish of the season in which it was used. It would be fair to say that more of the depreciation in certain classes of farm machinery is due to neglect than to use. Most farm machinery is employed during a limited period of the year, and some of it, e.g. binders and Combines, is in action for only a few weeks in the twelve months. This leaves a long period in which deterioration can take place, if the machinery is not properly looked after.

It should be the first task, when a machine has done its season's work, to see that it is cleaned, oiled and looked over. There is nothing to be gained in leaving a plough completely covered with mud, or a tractor smothered with grease and mud, after the ploughing season is over, but there is much to be lost. Systematic care, regular cleaning and occasional expert servicing will add enormously to the life of any farm implement.

Tractors.

Engine oil should be changed in tractors according to the makers' instructions and the brand of oil recommended by them should always be used. There is no economy in favouring cheap oil. The radiator should be flushed out regularly, and all greasing points consistently should have their shot of grease. With every new tractor is a maintenance chart, and it is to the owner's advantage to pay the strictest attention to it. At the end of the spring work, the tractor should be thoroughly washed down, all bright parts greased, cylinder head examined and decarbonized if necessary. Where loss of power has been noted, valves should

be attended to, and all bearings well treated with the grease gun in order to force out any grit that may have got through the felt seals. In using the tractor always be sure to keep up the oil level and maintain the necessary supply of water in the radiator. If the water has been drained out of the radiator and it is wished to move the tractor a short distance, on no account should that be done without replacing the water; even a short period of running under these conditions may cause the cylinder to crack.

Internal-Combustion Engines.

Where similar characteristics are found in internal-combustion engines as in tractors, the same care should be taken. As these engines are often in a wooden shed, perhaps exposed to the coldest winds, the water must be drained without fail from the cooling system when frost is to be expected, unless an anti-freeze mixture is in use.

Tillage Implements.

There is, as already indicated, a definite period during which any one tillage implement is used and the rest of the time it stands idle. The owner should make a point of seeing that, before it goes into storage, the implement is well washed down, and all grease points are given a good shot of the gun, exposed working parts, such as adjusting screws, &c., being cleaned out and then carefully regreased. The whole implement should be looked over to ascertain where spares will be required when it is to be used again, and an order placed for these spares at once.

At the time of writing, spares are very difficult to obtain. If there are broken parts about machines or parts very badly worn, but which look as if it might be possible to build them up, it is probable that the local blacksmith has either an oxy-acetylene or an electric welding plant and may be able to assist considerably in this matter.

Of all machines which suffer from neglect about the farm the fertilizer distributor is the chief victim. There is a persistent attack on metals by the action of artificial chemicals. Yet one often sees a manure distributor standing exposed to the weather with its box half full of manure waiting until the time comes to use it again! They should be emptied completely as soon as sowing is finished. As far as the make of the machine permits it should be taken to pieces and thoroughly cleaned. Those parts which come

in contact with fertilizer should be oiled either with waste oil from the tractor, or with waste oil with a little blacklead in it, and the machine should be put past under cover. It will then be undamaged and ready for use when the next sowing season comes.

Harvesting Machinery.

Harvesting machinery is used for the shortest period of any type of farm equipment. Therefore, great care should be taken of it during the time when it is not in use. It is advisable, in the case of reapers, binders and Combines to remove the canvasses, and any leather-strap backing should be given a rub with a rag soaked in castor oil. Precision chains should be removed, placed in a shallow pan and covered with paraffin oil. The whole machine must be cleaned down, all grease-gun nipples given a good shot of the gun, and cutting knives and sections should be carefully examined to see whether any need replacement. Wheels should be looked at –both transport wheels and working wheels –axles should be greased and the knotter especially should be very carefully cleaned, sharpening its knife, if considered necessary.

Food-preparing Machinery.

As these machines are used for longer, continuous periods than any others on the farm, troubles to be looked for in them are due to wear rather than to rust and dirt. As for all other machines, however, there is a slack period. During it the machinery should be carefully cleaned down, and thoroughly examined. If necessary, small repairs must be attended to and note made of the spare parts required, so that they may be ordered and already fitted when the time comes to start work again.

Pest-control Machinery.

As this class of equipment often is used to sprinkle or spray acids and corrosive materials it requires the very greatest care. All makers issue particular instructions with regard to such machinery and these directions should be faithfully followed. For example, one day's neglect may quite easily do £15 to £20 of damage to a sulphuric-acid spraying machine.

The foregoing remarks are addressed principally to those farmers who are not operating on a sufficiently large scale to employ a mechanic, or a blacksmith, of their own, but it is strongly recommended that every farmer, farmer's son, or person in charge of machines on a farm, should have at least a few months' training

in an agricultural-engineering workshop or in a workshop of an agricultural college. They would be amply rewarded for the time spent as they would be able to prevent breakdowns and attend to minor repairs in busy seasons. Take, for instance, Combine harvesters—they are very intricate machines, and, with a short period of tuition before the outfit is delivered *to the farm*, the operator subsequently may be able to spot anything going wrong and so save a hold-up on a harvest day.

Painting.

Practically all machinery is delivered from the factory painted, and farmers would be well advised to keep it painted. To do this successfully attention must be given to the proper cleaning of the machinery, otherwise the paint will not stay on; consequently, thorough examination is an essential preliminary. A good-quality paint should be selected and, among other sources, might be obtained from the makers of the machines. More care is certain to be taken of well-cared-for machinery during work than is likely to be given to similar machines if in a rusty and dilapidated condition.

Dairy Machinery.

Although cleanliness of all machines is stressed, dairy machinery in particular must be kept scrupulously clean and sterile. Particularly is this the case with milking machines. After each milking any dirt should be washed from the outside of the units, and two or three gallons of clean cold water should be drawn through the teat-cup clusters. It is desirable, if washing cannot be finished at the time, to leave the clusters soaking in clean cold water. Equally imperative is it that all milk residue is removed from rubber before the latter is sterilized. For the weekly wash the milking machine clusters should be dismantled and all other parts cleansed and sterilized. Do not oil the pulsator, but for engine and vacuum pump use the oil recommended by the makers.

Cream separators, like milking machines, require to be kept in speckless condition, although the materials used for the manufacture of separators now are of non-rusting steel. For the efficient working of the cream separator it is necessary to keep it well lubricated by means of the oil reservoir. Here again, the instruction manual supplied with a new machine must be closely followed. Proper attention to machines will save a lot of money.

CHAPTER VIII

Machinery comes into its own

As the farmer satisfies himself before he distributes manures or sows seeds on the soil that it is in a condition to receive them, so in the same way we assure ourselves that the farming industry is in a fit state to avail itself of mechanical equipment ere we say much in book form about that subject. Dame Agriculture is no longer an out-at-the-elbows Cinderella. As with most modern enterprises there must be up-to-date equipment. The farmer is machine-minded and can afford to be. His employees, compared to those of former days, are also machine-minded and wish to be. Engineers are farm-minded, and it pays them to be. Thus we have the ideal circumstances required to attain great things in providing farming necessaries. No longer is adequate equipment a luxury and a dream on the part of those engaged in a penurious agriculture, but it has become the everyday necessity of all types of farming.

Constant Changes.

One of the chief impressions formed through a lifelong association with the implement and machinery business is that there is scarcely such a thing as finality in design. There is constant change. This also affects books and writings on farm equipment to the extent that seldom, if ever, is there any statement that is " the last word " on the subject. With new sources of power on the horizon, invention and engineering enterprise will go on even more actively in the future than in the past.

There is a world shortage of food, and governments in many lands realize the need for extending the use of up-to-date farm equipment as a means of increasing production. These conditions favour the interests of inventors, engineers, and the users of farm appliances. Thus, until world needs in that line have been satisfied —and that will not be for a long time to come—changes in design, where improvements are involved, will be numerous, because of

the demand for machines, and the consequent rush of new ideas welcomed by manufacturers.

End of Food Surpluses.

Certainly the days of surplus food and surplus workers are over. Labour-saving machines can now have comparatively free play in ever-growing numbers and variety, without any suggestion that they are creating surpluses of food for which there is no sale, or that they are creating unemployment. The machine has come into its own, its proper rôle, as a saviour of mankind from grim food shortages. There will be an ever-increasing run on food-producing machinery for many years.

Providentially, mechanization has come to the rescue of the basic industry at the period when there was greatest need for effective assistance. It increases markedly the amount of food which the labour of one man can produce in any given time. This transition is all the more important because within recent years there has been a growing tendency for the individual worker to avoid hustle in tasks involving manual effort. Formerly there was a good deal of tears and sweat in farm work; but along came the machine, and the worker need no longer perspire although, with modern equipment, he produces many times more food than did the hand labourer of a few years ago.

" Speed " too, is the watchword of to-day, and it is an attitude befitting the use of the tireless machine. It steps up the output of food for two reasons. It covers the ground quickly, and it covers it at the correct season, the result being more acres cultivated, and better quality of crops grown.

The majority of successful innovations in the past were laughed at when first introduced, but the machine-minded farmers of to-day are less liable to err in that way. Presumably, however, a smile or two may be detected arising out of some of the more fanciful predictions of seers of a mechanical bent. Usually practical people are apt to reserve judgment until after years of testing and trying.

Machine power has eased our dependency upon man power and horse haulage to the substantial gain of food production. The machine, however, cannot cheat nature, any more than can man or horse, and it must have its supply of primary energy to make it work. Fortunately, despite the great increase in the use of fuel-greedy power-units, there is still a reasonably ample world supply

of the raw materials for motive purposes—coal, oil, spirit and electricity. The future for electricity in agriculture continues to brighten through the vast possibilities still to be tapped—" hydro ", tidal and wind. For the present we will say nothing about atomic possibilities.

Great Soil " Friabilizer ".

In equipment for ploughing it seems a practical expectation that, on favourable soils, the rotary tiller will compete rather more than at present with the plough at certain seasons in the year. Probably autumn wheat, for instance, may be manured and sown by the rotary tiller (specially designed) that prepared the tilth—all in one operation—the interdependent functions being " ploughing " (rotary tilling), manure distribution, and drill seed sowing. As an implement also for late-spring ploughing and cultivation, its popularity is bound to increase quickly. Apart from an increase in rotary tillers used, there will be few drastic changes in implements employed in spring, although minor improvements will continue to appear on account of better performance, cheaper manufacture, simplicity of design, or smarter appearance.

Summer machines will also undergo semi-routine changes, and mowers, grass cutters, hay machinery, grass driers, &c., will be redesigned without much radical alteration, unless in the realm of grass-drier design, and a greater use of air suction to pull grass and short crops on to and over mower blades or cutter knives.

Problem of Ensuring Straw Quality.

With harvest comes the Combine type of harvester. In a system of farming such as we have in most parts of Britain, where the agriculturists have been brought up with a profound respect for straw as a stock fodder, harvesting machines of all kinds, from reaper to Combine, are apt to be judged on the score or degree to which they afford a chance to secure the straw in wholesome palatable condition. Striving after that has always kept our farmers on their toes, since our average harvest climate is decidedly humid.

How far have modern machines to go to enable the farmer to live up to his old standard as a master-hand in creating winter stocks of sound sweet straw? At least in regard to dealing with standing crops, there should not be a great deal of alteration required in modern machines in order to safeguard the quality of the straw subsequent to the separating process.

Grain drying in most parts of Britain, again for climatic reasons, is the inseparable obligation of the farmer wherever a Combine-type harvester has been used, as mentioned on pp. 142-144. There should be a couple of drier outfits of fairish through-put in every parish, and all the better if they are of a dual-purpose design that would handle grass or grain.

The potato harvesters are in course of evolution and widespread use of these machines cannot be very far away.

In steading equipment there are still many openings for minor departures, from that used for the meticulous handling of milk to rough-and-ready up-loading devices for farm-yard manure. New methods for the sterilization of dairy utensils, and even of milk, butter and cheese, are just at hand and will come into use if they establish their economic feasibility.

Small Man is not Neglected.

It was a mistaken attitude over many years to imagine that mechanization of agriculture was the large farmer's province. Nothing could be further off the mark to-day, or is likely to be in the future. Already manufacturers have displayed considerable enterprise in producing equipment for small farmers and they, in turn, have invested extensively in machinery and implements.

Another factor extending the scope for machinery on the small farm is that the produce sold gives a greater cash return, and often it pays the smallholder to hire heavy plant for special operations, where formerly it would have been uneconomic to do so. But the era of the mechanization of smallholdings is only dawning, and there is no doubt that a large number of mechanical aids have still to be provided for the husbandman of few acres. With the price-assurance charter which is now their lot, it is only a question of time when a full complement of equipment will be available, and utilized.

As already noted the whole world is crying out for more and more food. That will be the case probably for all time to come, so far as can be seen, and this is of the utmost significance to those who read this book. The raw material and other requirements of the agricultural engineer are a priority consideration, and the user of his products is engaged also on a vital form of productive enterprise. No obstacles must be placed in the way. If their joint aims are realized, humanity as a whole will benefit.

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